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Real GDP and the Purchasing Power of Provincial Output

by Ryan Macdonald

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Table of contents

Abstract 5

Executive summary 6

1. Introduction 8

2. Real GDP versus real GDI 15

3. Terms of trade, real GDI and real GDP 20

3.1 Data and presentation 20
3.2 Canadian real GDP versus real GDI 20
3.3 Newfoundland and Labrador 25
3.4 Prince Edward Island 27
3.5 Nova Scotia 28
3.6 New Brunswick 30
3.7 Quebec 31
3.8 Ontario 33
3.9 Manitoba 34
3.10 Saskatchewan 36
3.11 Alberta 37
3.12 British Columbia 39

4. How important are trading gains? 40

5. Conclusion 43

Appendix A Mathematical derivations for real income adjustments 45

References 48

Abstract

This paper examines the impact of import and export price changes on economic welfare in Canada, and in each of the provinces. It examines how terms of trade shifts and fluctuations in the ratio of traded to non-traded goods prices affect the purchasing power of domestic production. Terms of trade shifts are shown to have a larger impact in the short run. Moreover, the paper shows that failing to account for terms of trade shifts, when analysing macroeconomic data, can lead to misinterpretations about the sources of growth or decline in consumption, investment and imports. The magnitude and direction of terms of trade fluctuations, and their impacts, vary by province and over time. Changes in commodity prices are shown to have important effects. The effect of terms of trade shifts is largest in Alberta and Newfoundland and Labrador, while Manitoba is relatively unaffected.

Keywords: gross domestic product (GDP), international trade, national accounts

Executive summary

Economists often assume that real gross domestic product (GDP)—a measure of the earnings generated from production—represents the volume of goods and services that can be purchased with those earnings. This assumption is valid for countries where a small percentage of GDP is derived from trade. However, for a small open economy, such as Canada, where trade activity represents a significant portion of nominal GDP, changes in the relative price of traded and non-traded goods, or in the relative price of exports and imports, can have important consequences.

In particular, the terms of trade (the ratio of export to import prices) and the real exchange rate (the ratio of traded to non-traded goods prices) can affect the volume of goods and services that can be purchased with real GDP. Terms of trade shifts change the number of imports that can be purchased with a given level of exports. Improvements in an economy's terms of trade are therefore analogous to productivity growth: economic agents are able to consume more goods and services from their available resource base. Real exchange rate changes capture increases (decreases) in nominal income that arise from agents earning more (less) from net exports.

The combination of the two effects is the trading gain a country realizes when the price ratios change. By adjusting real GDP for trading gains it is possible to create a measure of the real purchasing power of income referred to as real gross domestic income (GDI). This paper examines the evolution of real GDP and real gross domestic income (GDI) from 1981 to 2005 in Canada and in the provinces. In doing so, it examines a number of questions pertinent to understanding the evolution of the domestic economy:

1. Is there a preferable method for calculating real GDI?

   - The difference between real GDP and real GDI comes from how exports and imports are treated. Real GDP deflates exports and imports separately, while real GDI deflates net exports. Consequently it is necessary to choose a net export deflator. While there is no consensus about which choice of deflator is optimal, in this paper the final domestic demand (FDD) deflator is employed. The FDD deflator makes it possible to disaggregate trading gains into real exchange rate and terms of trade effects. Other deflator choices (including export or import prices or their geometric mean) lead to solutions that are constrained versions of this adjustment.

2. Which effect is more important: the terms of trade or the real exchange rate?

   - For most provinces the terms of trade effect is more important. The result arises because the magnitude of the terms of trade effect is proportional to the average share of imports and exports in nominal GDP, while the real exchange rate effect is proportional to the share of net exports. In most provinces, the share of net exports is small while the average of the export and import shares is large. The terms of trade, therefore, are more important for understanding the evolution of provincial real GDI. However, in Nova Scotia and New Brunswick there are trade deficits that lead to a larger magnitude real exchange rate effect. As a result, the real exchange rate and terms of trade effects both lead to noticeable changes in their respective real GDIs.

- In Canada the share of exports and imports is large, relative to net exports. Consequently, terms of trade fluctuations have a larger impact on Canadian real GDI than real exchange rate movements.

3. What are the sources of trading gains?

   - Trading gains are primarily driven by commodity price changes, fluctuations in the Canada–U.S. dollar exchange rate and imported machinery and equipment prices. As a result, foreign productivity growth, current account corrections and fiscal and monetary policies can also be important determinants of trading gains.

4. When are trading gains the most influential?

   - Trading gains are predominantly a short-run phenomenon. They capture changes in the purchasing power of real GDP that arise from relative price shifts, which manifest themselves quickly in the domestic economy as changes in imports, consumption and investment. Importantly, trading gains can lead to real GDI, consumption and import growth without an accompanying change in real GDP.

5. How have trading gains affected the economy recently?

   - Increases in commodity prices, and the appreciation of the Canadian–U.S. dollar exchange rate, have led to significant increases in trading gains for many provinces, as well as for Canada. A number of provinces have experienced trading gains from 2002 to 2005—notably British Columbia, Alberta, Saskatchewan, Nova Scotia and Newfoundland and Labrador. Moreover, while trading gains have held back real GDI in Ontario, there has not been a similar effect in Quebec.

   - From 2003 to 2005, rising energy and commodity prices led to positive trading gains in a wide range of provinces. This differs from the early 1980s, when trading gains in energy exporting regions were offset by losses in energy importing regions. The purchasing power growth of the Canadian economy, rather than being dampened by offsetting regional effects, has expanded since 2002. Consumers and business across the country have benefited from the trading gains that have contributed to consumption, investment and import growth.

1. *Introduction*

Real gross domestic product (GDP) measures the valued added, or income earned, from production that occurs during a particular period of time, within a set of geographical boundaries. It is measured in constant dollars and designed to track changes in the volume of value added production over time; however, it is not always viewed in this fashion. Because nominal GDP, by construction, equals the value of final expenditures, income and the sum of value added from production, economists often assume that real GDP can be viewed as a measure of the real volume of goods and services that can be purchased with the income earned through production. While real GDP is a measure of real earnings from production, the assumption that it also represents the purchasing power of those earnings is misleading.

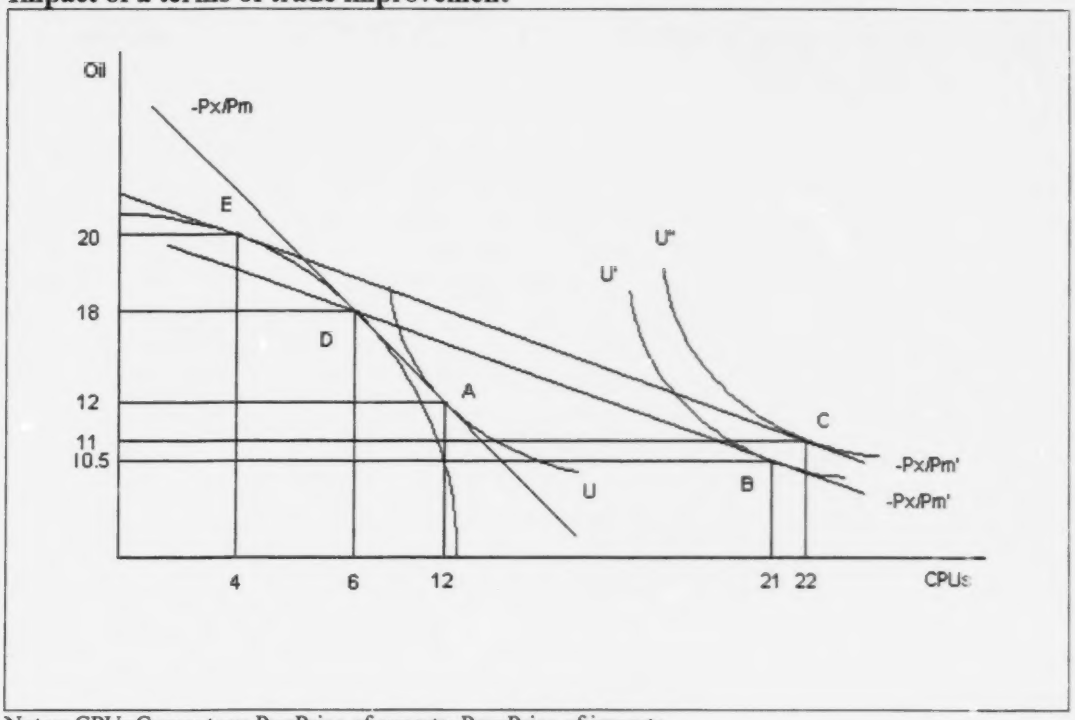
National accountants have long recognized the difference between earned income and the purchasing power of that income. To account for this difference, a measure of real income that adjusts for purchasing power is needed. The 1993 System of National Accounts details how this purchasing power measure can be calculated and defines it as real gross domestic income (GDI).

The difference between real GDP and real GDI is important to understanding the well-being of individuals and the evolution of the domestic economy. Only if a country does not engage in trade will real GDP and real GDI necessarily be equal. If a country trades with other nations, trade patterns and relative price changes can have important consequences for how much an economy can purchase (real GDI) with what it earns through production (real GDP).

There are two important price ratios that can lead to a divergence between real GDP and real GDI. The first is the terms of trade. This is defined as the price of what a country sells to the rest of the world, its export price, relative to the price of what it purchases, its import price. The terms of trade represents the number of domestic goods and services that must be foregone to acquire a foreign good or service. A shift in the terms of trade, therefore, represents a real change in the volume of goods and services that an economy can purchase with what it earns.

Terms of trade shifts can be triggered by a number of phenomena, some of which are particularly noteworthy for Canada and its provinces. First, because some economies export large volumes of commodities, while importing manufactured goods, changes in commodity prices can have significant effects on their terms of trade. Second, changes in the nominal exchange rate can trigger terms of trade shifts. As a result, current account imbalance corrections, monetary policy, fiscal policy, and foreign demand for domestic goods and securities, among other causes, can lead to terms of trade shifts. Finally, productivity growth can lead to terms of trade shifts. A notable example that affects Canada is machinery and equipment, particularly computers and telecommunications equipment. Over the last 15 years, there have been productivity increases in the United States and abroad that have led to decreases in the prices of these goods over time. The declining prices, in turn, have translated into terms of trade improvements for Canada. As a result, Canadians have been able to "import" the productivity gains experienced in the United States.

Figure 1
Impact of a terms of trade improvement



Notes: CPU=Computers; Px=Price of exports; Pm=Price of imports.
Source: Statistics Canada, author's calculations.

Terms of trade shifts are important because they can induce welfare changes by affecting final domestic demand, exports and imports. Moreover, because terms of trade shifts originate from price movements, their impacts can manifest themselves quickly. To understand why, consider the following example depicted in Figure 1.

Suppose that economic agents maximize their welfare by consuming oil and computers. They choose to consume additional units of each good until the marginal rate of substitution between oil and computers equals the terms of trade. Based on the set of preferences contained in the representative utility curve U, and the terms of trade, agents then allocate productive resources within the economy to reach the highest possible utility curve. They reach the highest possible utility curve when the ratio of the opportunity cost of producing oil to computers is equal to the terms of trade. At this point the slope of the production possibilities frontier (PPF) is equal to the negative of the terms of trade and the negative marginal rate of substitution along the agent's utility curve. In Figure 1 these conditions are met when the economy produces at point D and consumes at point A.

Table 1
Impact of a terms of trade improvement

	Levels			Growth rates	
	A	B	C	A to B	B to C
Volumes					
Oil (consumed)	12	10.5	11.0	-12.5	4.8
CPUs (consumed)	12	21	22.0	75.0	4.8
Oil (exported)	6	7.5	9	25.0	20.0
CPUs (imported)	-6	-15	-18	150.0	20.0
Prices					
P(oil)	1	1	1	0.0	0.0
P(CPU)	1	0.5	0.5	-50.0	0.0
Px(oil)	1	1	1	0.0	0.0
Pm(CPU)	1	0.5	0.5	-50.0	0.0
Terms of trade	1	2	2	100.0	0.0
Nominal values					
Final expenditure GDP	24.0	21.0	22.0	-12.5	4.8
Consumption	24.0	21.0	22.0	-12.5	4.8
Exports	6.0	7.5	9.0	25.0	20.0
Imports	-6.0	-7.5	-9.0	25.0	20.0
GDI	24.0	21.0	22.0	-12.5	4.8
Real values					
Laspeyres					
Final expenditure GDP	24.0	24.0	25.1	0.0	4.8
Consumption	24.0	31.5	33.0	31.3	4.8
Exports	6.0	7.5	9.0	25.0	20.0
Imports	-6.0	-15.0	-18.0	150.0	20.0
GDI	24.0	31.5	33.0	31.3	4.8
Consumption deflator	1.00	0.67	0.67	-33.3	0.0
Paasche					
Final expenditure GDP	24.0	24.0	25.1	0.0	4.8
Consumption	24.0	28.0	29.3	16.7	4.8
Exports	6.0	7.5	9.0	25.0	20.0
Imports	-6.0	-15.0	-18.0	150.0	20.0
GDI	24.0	28.0	29.3	16.7	4.8
Consumption deflator	1.00	0.75	0.75	-25.0	0.0
Fisher					
Final expenditure GDP	24.0	24.0	25.1	0.0	4.8
Consumption	24.0	29.7	31.1	23.7	4.8
Exports	6.0	7.5	9.0	25.0	20.0
Imports	-6.0	-15.0	-18.0	150.0	20.0
GDI	24.0	29.7	31.1	23.7	4.8
Consumption deflator	1.00	0.71	0.71	-29.3	0.0

Notes: CPU=Computers; P=Price; Px=Price of exports; Pm=Price of imports; GDP=Gross domestic product; GDI=Gross domestic income.

Given points A and D, a number of economic aggregates can be formed. First, by making oil the numeraire good, and recognizing that the opportunity cost of oil for computers at point A is one barrel of oil for one computer, it is possible to assign a price, in terms of oil, to the goods. In particular, at point A each good has a price equal to one barrel of oil.

Using the price and volume information, the economy produces at point D where it earns income (GDP) equal to 24 barrels of oil. This income is used to purchase domestic and foreign goods (real GDI). In current dollars, GDP and GDI are, by definition, equal.[1] Nominal GDI is, therefore, equal to 24 barrels of oil. Since the economy is producing 18 barrels of oil and only consuming 12 barrels, the difference—6 barrels of oil—constitutes exports. Similarly, since the economy consumes more computers than it produces—12 consumed versus 6 produced—the difference must equal to the economy's imports of 6 computers.

This set of aggregates constitutes equilibrium in the economy in period 1, and is displayed in Table 1. In subsequent paragraphs the impact of a terms of trade improvement on this economy is examined. The response of the economy is divided into two parts that examine the impact of the relative price change on real and nominal GDP, GDI, consumption, exports and imports. At the end of the third period the economy will have returned to equilibrium. In each period, real GDP and real GDI are compared. Real volumes are calculated using Laspeyres, Paasche and Fisher indices to illustrate the influence of the differing deflation methods.

Suppose that, at the start of period 2, the foreign country experiences productivity growth in its computer manufacturing industry that leads to a decrease in the price of computer imports for the home country. Suppose further that the price of computers falls by 50%. When this occurs the terms of trade will immediately improve, rotating through point D, potentially allowing economic agents to reach a higher level of utility at curve U'.

Consumers take advantage of the terms of trade improvement by changing the volume of exports, imports and consumption. In the simplified economy of Figure 1 this happens instantaneously. Agents move from consuming at point A to consuming at point B.

Importantly, the move from A to B is not accompanied by an increase in total goods produced. The economy continues to produce at point D, earning real income equal to 24 barrels of oil. However, the value of that income (real GDI) increases by between 31.3% and 16.7% as the number of imports that can be purchased with available exports increases.[2] This salient feature of how terms of trade shifts affect the economy is illustrated in Figure 1.

Moreover, as is shown later, economic agents are able to quickly adjust imports and exports in response to a terms of trade shift. Figure 1, therefore, illustrates an important point: when terms

1. In this section, real consumption and real gross domestic income (GDI) are equal. In subsequent sections, real GDI reflects the volume of goods and services that can be purchased with domestic production. It will, therefore, also include investment, housing and government expenditures that are not present in the stylized economy of Figure 1.
2. The example assumes instantaneous pass through of foreign price changes to domestic prices. This simplification is useful for illuminating how a terms of trade shift affects the domestic economy. In the real world, the degree of pass through and its timing will depend on a number of factors, including market structure, the type of good and income and price elasticities.

of trade shifts occur, it is possible to see changes in purchasing power of real value added without an accompanying change in real value added.

The example also makes it clear that the terms of trade improvement is analogous to productivity growth, as the economy is able to consume more goods and services from its available resource base.[3] Further, it illustrates the difficulty that analysts who assume that real GDP is a measure of the purchasing power of real income face when terms of trade shifts contribute importantly to consumption, export and import growth.

Finally, following the shift to point B, agents in period 3 reallocate production to once again reach the highest possible indifference curve. They decrease computer production and increase oil production. The higher oil production leads to more consumption and an increase in exports and imports. Production moves from point D to point E. Nominal GDP increases moderately while real GDP expands by 4.8%. Real GDI increases by the same amount as the value of the lost computer production is offset by the gain from increasing oil production. Both imports and exports expand by 20% as the reallocation takes place.

The second important price ratio is the relative price of traded to non-traded goods and services. This ratio is often viewed as a real exchange rate because changes in it are associated with changes in the domestic economy's purchasing power.[4] To understand why, consider an expansion to the example economy. The expansion adds a third good which increases the dimensionality of the problem. The outcome cannot, therefore, be seen in Figure 1.

Suppose that, as well as producing and consuming oil and computers, restaurant meals are also produced and consumed. Further, suppose that all traded goods are sold to the world market in period 1, but are not delivered until the start of period 2. Rather than viewing period 2 as a single event, it is now broken into three sub-periods. In the first sub-period the price of computers falls for consumers, while producers receive the old, higher price that they contracted to sell computers at in period 1. Traded goods producers, therefore, earn income equivalent to 24 barrels of oil. In the second sub-period, consumers purchase 12 barrels of oil and 12 computers. Since the price of computers has fallen, they only spend income equivalent to 21 barrels of oil, leaving them with an additional 3 barrels. In the third sub-period consumers recognize that the price of computers has fallen. They, therefore, go back onto the world market and trade some of their oil for computers.

By dividing period 2 into sub-periods, the example illustrates that relative price shifts can lead to two real income effects. The first affects how much real income is earned through trade activity—the real exchange rate effect. In the example, real income earned through trade activity increases because agents are able to sell their production on world markets before the decline in computer prices and purchase goods for consumption after the decline. The second affects the rate at which exports are traded for imports—the terms of trade effect. In the example, the terms

3. This point is argued succinctly by Diewert and Morrison (1985) who show that terms of trade improvements are similar to technological progress.
4. This terminology can be misleading. It is common in the literature that focuses on trading gains and, for that reason, is adopted here (see for example Corden [1960] and Salter [1959]). It should not, however, be confused with the more commonly used real exchange rate discussed in the macroeconomic literature.

of trade effect is captured in the third sub-period when agents recognize that prices have changed and reallocate their consumption of oil and computers accordingly. In the absence of the real exchange rate effect, the terms of trade effect will still be present.

How the real income gain from the real exchange rate change is spent is critical to understanding its impact on the economy. If consumers decide to purchase additional computers with the income, they will end up importing 15 computers and exporting 7.5 barrels of oil. This is the same outcome as the earlier example where only tradable goods exist. However, it is now possible for consumers to purchase additional meals instead of additional traded goods. If they choose to purchase only meals, and prices remain unchanged, then domestic output will increase. It is also possible that they choose to purchase a combination of the traded and non-traded goods.

However, up to this point there have been no supply response constraints. Whenever consumers have income they are able to translate it immediately into goods. If supply does not respond instantly—is not infinitely elastic—increased demand will also translate into price movements. For traded goods, it is unlikely that a small open economy, such as the one in the example, will affect prices. However, in the domestic economy it is unlikely that supply is infinitely elastic. Therefore, if the income saved by consumers when they first purchase computers abroad is spent on restaurant meals, it can lead to domestic inflation.

If there is a constrained supply response and consumers purchase restaurant meals, the declining price of computers and the increasing cost of restaurant meals will work against each other in the consumption price index. Similar effects occur in the real world; however, the process is more complicated. The speed of price and quantity adjustments rely on market structures, own price, cross price and demand elasticities, the relative weights of the goods in the consumption price index, as well as on potentially offsetting movements in other variables, such as the nominal exchange rate.

Nevertheless, agents in the model economy are affected by the real exchange rate depreciation and the terms of trade improvement. Moreover, regardless of how agents choose to spend their savings from the real exchange rate depreciation, they are able to benefit from the terms of trade improvement.

Additionally, because there have been changes in the relative price of traded and non-traded goods, and between oil and computers, the adjustment of the economy toward long-run equilibrium contains an additional component. Not only does production shift away from computers and toward oil, the relative price shift also leads to a reallocation of productive resources away from restaurant meal production toward traded goods production. Since the price of traded goods has fallen relative to non-traded goods, demand for traded goods increases while demand for non-traded goods falls. As the domestic economy adjusts, there is a shift away from restaurants toward traded goods production. Within the traded goods category, oil production offers the highest return, leading to a reallocation of resources away from restaurant meal production and toward oil production.

Changes in relative prices will, over an extended time period, lead to a reallocation of productive resources within an economy. This process is a movement along the production possibilities

frontier (PPF). Once completed, the economy is in a state of equilibrium where, in the example, the opportunity cost of foregoing an additional computer and producing an additional barrel of oil is equal to the terms of trade, which is equal to the marginal rate of substitution between oil and computers in the economic agent's utility function. Additionally, the real exchange rate is equal to the marginal rate of substitution between traded and non-traded goods in the agent's utility function.

Fluctuations in the real exchange rate can be triggered by, for example, changes in the domestic price level, exogenous changes in export, or import, demand or supply that result in price shifts, or changes in the nominal exchange rate. Although a combination of effects is likely present at any given time, making it difficult to discern which effect is the most influential, changes in the relative price of traded to non-traded goods and services can be important for understanding the evolution of real GDI.

It is important to note that the purchasing power changes captured by real exchange rate fluctuations and terms of trade shifts are short-run phenomena that are completely derived from changes in real income generated through trade activity. They do not represent changes in tastes or a movement along the PPF in the short-run.

When the growth rates of real GDP and real GDI are compared, the difference between them is defined as the trading gain.[5] In the above examples the trading gains equal the sum of the two real income effects. Trading gains should not be confused with gains from trade, which reflect the benefits of moving from autarky to an open economy. Trading gains capture the impact of relative price changes on the purchasing power of real GDP, and they may have a negative or positive impact depending on the direction of the relative price movements.

While both responses affect welfare by changing real income, they do not necessarily affect it in the same manner. It is possible to generate positive welfare gains through terms of trade improvements that are partially, or completely, offset by changes in the real exchange rate. It is also possible that both responses improve (worsen) welfare.

It is important to note that the timing of the responses will dictate when their largest effects are realized. When prices change, the volume of goods and services that can be consumed by individuals quickly adjusts. The trading gains (or real income effects), which are derived from price fluctuations, manifest themselves quickly. However, substitution effects appear more slowly since they require new investment and possibly new training for workers. While the example has alluded to the fact that these adjustments take time, in reality the reallocation may take place over a number of years as productive assets are not easily moved from one activity to another. As a result, while changes in investment patterns are important for long-run real income growth, they will not be as important for short-run real income growth as the trading gains are.

This paper examines the impact of trading gains on Canadian real GDI growth, and provincial real GDI growth, from 1981 to 2005. It focuses on short-run, year-to-year changes. The analysis is ordered as follows. Section 2 explains how changes in relative prices affect real GDI, and how

5. The System of National Accounts refers to trading gains as ". . . the difference between the change in GDP at constant prices and real GDI . . .", SNA 1993, p. 404, Section 16.152.

real GDI is related to real GDP. Section 3 compares real income and real GDP in Canada, and by province, while Section 4 discusses the importance of relative price changes. Section 5 concludes.

2. *Real GDP versus real GDI*

To assess how important trading gains are, a real gross domestic income measure is needed. Since economic theory and statistical practice dictate that nominal gross domestic product (GDP) and nominal gross domestic income (GDI) are equal, the difference between real GDP and real GDI will be determined by their respective deflators.

The GDP deflator is designed to account for all price changes, regardless of their source. As a result, when final domestic demand, export or import prices change there is an accompanying change in the GDP deflator. The GDP deflator, therefore, treats terms of trade changes as price phenomena. While this feature makes real GDP a measure of the real value added, or real earnings, from production, it prevents real GDP from illuminating how terms of trade shifts affect the volume of goods and services that can be purchased.[6]

To capture the impact of terms of trade shifts, a GDI deflator that allows relative price changes to affect the number of traded goods and services that may be purchased is necessary. The GDI deflator achieves this by using the same price index for exports and imports. This approach is equivalent to deflating net exports rather than exports and imports separately. By deflating net exports the GDI deflator does not remove changes in purchasing power that originate from trade activity. Rather than capturing the volume of exports and imports from the economy, the GDI deflator captures the volume of imports that can be purchased with a given volume of exports.

It is important to note that the GDI deflator captures relative price changes that affect the volume of imports that may be purchased with a given volume of exports. Therefore, real GDI adjusts quickly, and may reflect the impact of a terms of trade shift before volumes begin to change. In the example described in Figure 1, real GDI changes at the beginning of period 2 when the terms of trade rotates through point D. All subsequent movements capture agents in the economy reacting to the terms of trade improvement. However, in reality, high frequency data are often not available and this can make it look as if real GDI and economic aggregates react simultaneously.

To illustrate the difference between the GDP and GDI deflators, suppose that there is a *ceteris paribus* appreciation of the nominal exchange rate that lowers the price of imports. All else equal, the appreciation means that less domestic income is spent purchasing foreign goods, which raises nominal GDP. Since the GDP deflator adjusts to account for price change, the volume of GDP will not change.

6. Real gross domestic product will, however, adjust when the level of value added changes because of productivity growth or a change in input levels.

Suppose, also, that the GDI deflator values imports and exports with the final domestic demand price index. This choice allows the nominal appreciation to affect the volume of goods and services that may be purchased in two ways. First, when the nominal exchange rate appreciates, it lowers the price of traded goods relative to non-traded goods—a real exchange rate appreciation—expanding the economy's purchasing power. Second, the import price falls relative to the price of exports—a terms of trade improvement—allowing the economy to purchase more imports for the same level of exports. Therefore, the level of real GDI will increase due to trading gains, which is a combination of two real income effects.

The above example also illustrates two additional differences between GDP and GDI. First, while real GDI has increased, there is no accompanying increase in the volume of imports. Although the example in Figure 1 assumes there is an instant response, in reality there is no guarantee that an increase in real GDI from trading gains will lead to an accompanying increase in real consumption if additional consumption has to come from this source. The increase may, instead, translate into greater savings. Second, if the lower import price is allowed to affect import volumes, economic theory suggests that import volumes will rise. If the rise leads to substitution away from domestic production, the increased level of imports will tend to lower real GDP. Real GDI, however, increases. The paradoxical result that a nominal exchange rate appreciation can lower real GDP while raising real GDI, therefore, becomes apparent.

The GDI deflator is mechanically calculated in the same fashion as the GDP deflator. However, a decision about which price index should be used to value imports and exports must be made. The 1993 System of National Accounts (SNA 1993) does not explicitly preclude any method for deflating net exports. It does, however, note that:

> There is a large but inconclusive literature [about selecting which price index to use to deflate net exports], but one point on which there is general agreement is that the choice of [that index] can sometimes make a substantial difference in the results. Thus the measurement of real GDI can sometimes be sensitive to the choice of [the price index] and this has prevented a consensus being reached on this issue.
>
> SNA 1993 16.153

Denison (1981), following the view that net exports should be deflated using an import price index, establishes the term "Command GDP" to describe real GDI in the United States.[7] This is the same measure described in the SNA 1993. Denison's terminology and methodology are subsequently used by the National Income and Product Accounts in the United States when producing their Command GDP measure.

In Canada, the National Income and Expenditure Accounts from the second quarter of 1977 (1977Q2) provide an early series for real GDI. In the 1977Q2 National Accounts, which pre-date the current mnemonic conventions of SNA 1993, a terms of trade adjusted real income series that is called real gross national product (GNP) is produced. The series uses the gross national expenditure deflator, net of export prices, to deflate nominal expenditures.

7. For a historical discussion of price index choice that begins with A.L. Bowley in 1944, see the Appendix in Denison (1981).

Conceptually, Denison's Command GDP and the 1977Q2 National Account's real GNP are similar since both remove the effect of export prices from an aggregate deflator, though they do so in different ways. However, the changing terminology can lead to a degree of confusion. In this paper the SNA 1993 naming conventions are applied to the terms of trade adjusted real income series.

The SNA 1993 offers a number of suggestions for price indices to deflate net exports. Four of these suggestions are discussed here. However, they do not represent an exhaustive list, and since there is no clear consensus about which method is preferable, the deflator ultimately used in this paper should not be viewed as definitive. Researchers and analysts should consider the appropriateness of the differing measures when examining particular problems. The four suggestions taken from the SNA 1993 are:

1) exports are valued using import prices;
2) imports are valued using export prices;
3) imports and exports are valued using the geometric mean of their respective prices; and
4) imports and exports are valued using final domestic demand prices.

In the present context, the first three methods are less desirable for discussing how relative price changes affect real GDI. They lead to analytical solutions where only terms of trade shifts affect real GDI and do not allow for the explicit inclusion of relative price shifts between domestic and traded goods and services prices. Moreover, the weight attached to the terms of trade effects from the first two methods depend on the nominal share of exports or imports respectively. The magnitude of the trading gain impact is, therefore, sensitive to the choice of deflator. The third method resolves this problem by using an average of the import and export shares.

The fourth method, as will be shown below, is viewed as a complete measure of relative price movements because it captures real exchange rate and terms of trade effects. It is, therefore, viewed as a preferable measure in this paper. The first three methods can be viewed as constrained versions of the fourth. Using the final domestic demand deflator provides more information, and is more consistent with existing theory than the first three methods. Additionally, it has the advantage of simplicity. Provided an analyst does not need to decompose trading gains into real exchange rate and terms of trade effects, employing the final domestic demand deflator is straightforward and easily applicable using widely available statistics.

It is important to note that real GDP and real GDI are closely related. In fact, real GDI growth—as will be illustrated in the following derivation—can be calculated by adjusting real GDP growth for trading gains (real exchange rate and terms of trade effects). As a result, real GDI growth will be affected by real GDP growth, which captures changes in inputs and technology, as well as purchasing power changes due to trading gains. All adjustments are made using Törnqvist indices which are based on growth rates; nominal GDP and nominal GDI being equal.

Let $\ln(P_{Y,t/t-1})$ be the Törnqvist index for the GDP deflator, which is written as: [8]

8. Derivations in this paper closely follow Kohli (2005).

$$\ln(P_{y,t/t-1}) = \sum_i \overline{v}_{i,t/t-1} \ln(P_{i,t/t-1}) \quad i = FDD, X, M$$

where FDD, X and M represent final domestic demand, exports and imports; and,

$$v_{i,t} = \frac{\gamma_i}{GDP} \quad \gamma_i = FDD, X, M \text{ ; and}$$

$$\overline{v}_{i,t/t-1} = \frac{(v_{i,t} + v_{i,t-1})}{2} \quad i = FDD, X, M$$ [9]

Real GDP growth is defined as nominal GDP growth minus GDP deflator growth:

$$\ln(y_{Y,t/t-1}) = \ln(GDP_{t/t-1}) - \ln(P_{Y,t/t-1}) \qquad (1)$$

Real GDI deflator growth is assumed to equal final domestic demand deflator growth:

$$\ln(P_{GDI,t/t-1}) = \ln(P_{FDD,t/t-1})$$

Real GDI growth is equal to nominal GDP growth minus final domestic demand price growth:

$$\ln(y_{GDI,t/t-1}) = \ln(GDP_{t/t-1}) - \ln(P_{GDI,t/t-1})$$

The trading gains from relative price changes are the difference between the real GDI growth and real GDP growth:

$$\ln(T_{t/t-1}) = \ln(y_{GDI,t/t-1}) - \ln(y_{Y,t/t-1}) \qquad (2)$$

which reduces to the difference between GDP deflator growth and GDI deflator growth:

$$\ln(T_{t/t-1}) = \ln(P_{Y,t/t-1}) - \ln(P_{GDI,t/t-1})$$

By rearranging (2) real GDI growth is equal to real GDP growth plus trading gains:

$$\ln(y_{GDI,t/t-1}) = \ln(y_{Y,t/t-1}) + \ln(T_{t/t-1}) \qquad (3)$$

However, equation (3) does not provide a great deal of insight into how changes in relative prices affect real income. To generate a more intuitive expression define:

9. The gross domestic product deflator also includes inventories and a statistical discrepancy. These are omitted from the analytical section.

- terms of trade growth as:

$$\ln(ToT_{t/t-1}) = \ln(P_{X,t/t-1}) - \ln(P_{M,t/t-1});$$

- growth in traded prices as:

$$\ln(P_{T,t/t-1}) = \frac{1}{2}\left(\ln(P_{X,t/t-1}) + \ln(P_{M,t/t-1})\right); \text{ and}$$

- growth in the real exchange rate, which captures changes in the relative price of traded to non-traded goods and services, as:

$$\ln(E_{t/t-1}) = \ln(P_{T,t/t-1}) - \ln(P_{FDD,t/t-1})$$

Using these definitions and (3), it can be shown that trading gains are the weighted sum of the real exchange rate and terms of trade movements:[10]

$$\ln(T_{t/t-1}) = (\bar{v}_X - \bar{v}_M)\{\ln(E_{t/t-1})\} + \frac{1}{2}(\bar{v}_X + \bar{v}_M)\{\ln(ToT_{t/t-1})\} \qquad (4)$$

By combining (3) and (4), it becomes clear that real GDI is real GDP growth plus the weighted sum of real exchange rate and terms of trade adjustments:

$$\ln(y_{GDI,t/t-1}) = \ln(y_{Y,t/t-1}) + \left[(\bar{v}_X - \bar{v}_M)\{\ln(E_{t/t-1})\} + \frac{1}{2}(\bar{v}_X + \bar{v}_M)\{\ln(ToT_{t/t-1})\}\right] \qquad (5)$$

The combination of real exchange rate and terms of trade effects in equation (5) stems from the decision to use the final domestic demand deflator for exports and imports. Suppose, for example, the geometric mean of export and import prices is employed instead. In this case, which is the third method for calculating real GDI above, only the terms of trade adjustment will affect real GDI. As a result, only a partial adjustment is made if the final domestic demand deflator is not used.

It is important to note that the weights attached to the real exchange rate and terms of trade changes have economic significance. The sign of the real exchange rate weight, $(\bar{v}_X - \bar{v}_M)$, is positive (negative) when the trade balance is in surplus (deficit), while its magnitude captures the size of the surplus (deficit) relative to nominal GDP. The weight attached to terms of trade growth, $\frac{1}{2}(\bar{v}_X + \bar{v}_M)$, is the average value of trade as a proportion of nominal GDP. As a result, real GDI in countries that are more open to trade is more susceptible to terms of trade shifts, and a larger trade imbalance makes real GDI more susceptible to real exchange rate movements.

10. See Appendix A.

3. *Terms of trade, real GDI and real GDP*

3.1 Data and presentation

The data for gross domestic product (GDP), final domestic demand, exports, and imports come from the Provincial Economic Accounts. It is important to note that while the analytic section above focuses on final domestic demand, imports and exports, GDP also includes inventories and a statistical discrepancy. As a result, the analytical solution is an approximation based on the components of GDP that constitute around 99% of total GDP. Therefore, there is a small discrepancy between real gross domestic income (GDI) calculated using the analytic solution and real GDI calculated by deflating nominal GDP with the final domestic demand deflator.

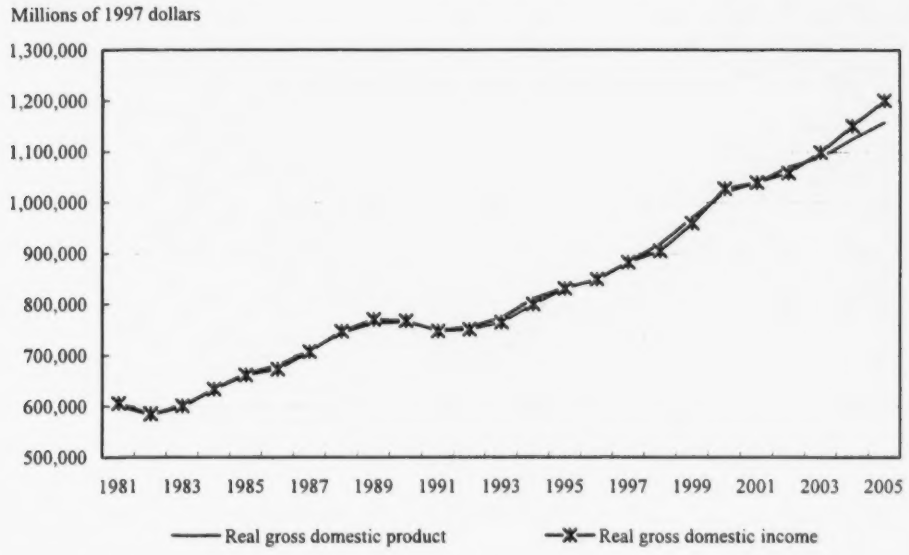
To present the data in a succinct format, the real GDP and real GDI Törnqvist indices are converted back to level indices, using 1997 as a base year. Differences in growth rates between the real GDP and real GDI can be seen when the gap between their respective levels expands or contracts. Reference is occasionally made to percentage differences between these real levels. These references should always be interpreted as relative to the 1997 base year. As well as the level series, a second figure presents the contribution to real GDI growth from trading gains. Trading gains are disaggregated into terms of trade and real exchange rate effects to show the relative importance of each factor.

3.2 Canadian real GDP versus real GDI

Canadian real GDP and real GDI are similar for most of the sample period (Figures 2 and 3). From 1981 to 2002 there is little deviation of real GDP from real GDI, suggesting that real GDI growth during the period is driven by real value added growth. After 2002, however, real GDI growth accelerates due to trading gains. In 2003, trading gains contribute 2.0 percentage points of growth to real income, while in 2004 and 2005 they contribute 1.4 percentage points. In all three years, the contribution to GDI growth from trading gains is driven by an ongoing terms of trade improvement. As a result, from 2002 to 2005, real GDI in Canada expands by 13.4% while real GDP only increases by 8.3%.

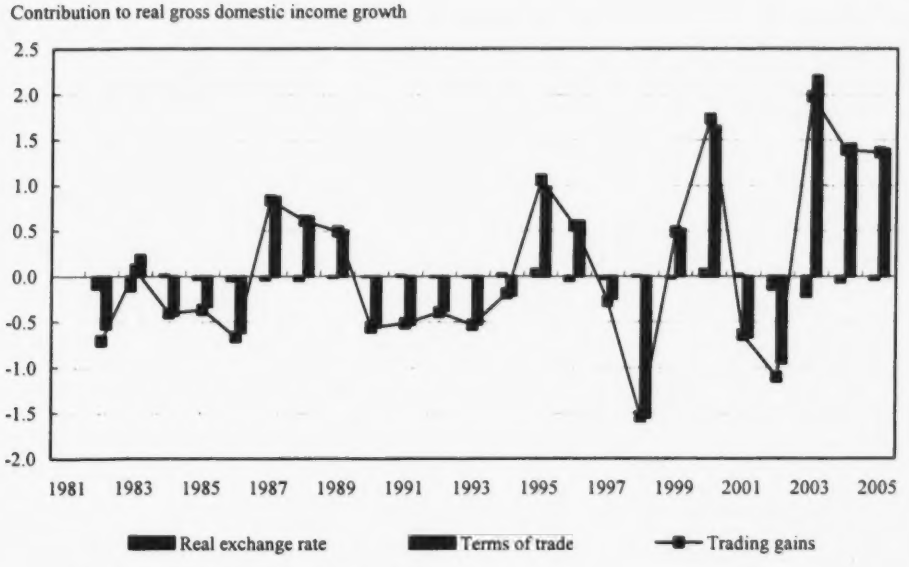
This result is noteworthy for a number of reasons. First, the terms of trade is the dominant factor affecting trading gains. During the sample period, terms of trade shifts tend to be smaller than real exchange rate appreciations and depreciations (Figure 4). However, the trade balance as a proportion of nominal GDP is relatively small, while the average nominal share of imports and exports is relatively large (Figure 5). As a result, real exchange rate fluctuations receive a lower weight than the terms of trade shifts. The impact of the real exchange rate is muted, and terms of trade shifts dominate changes in trading gains.

Figure 2
Canada



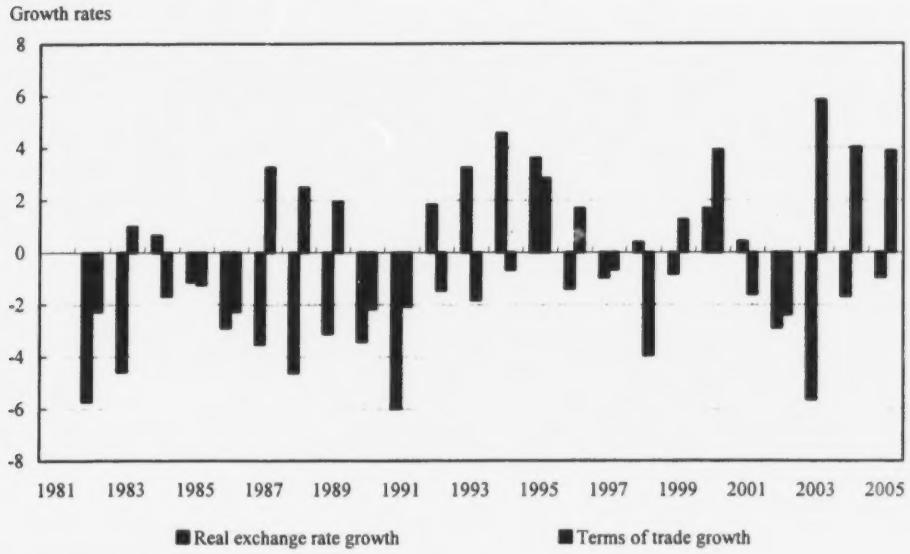
Source: Statistics Canada, author's calculations.

Figure 3
Canada



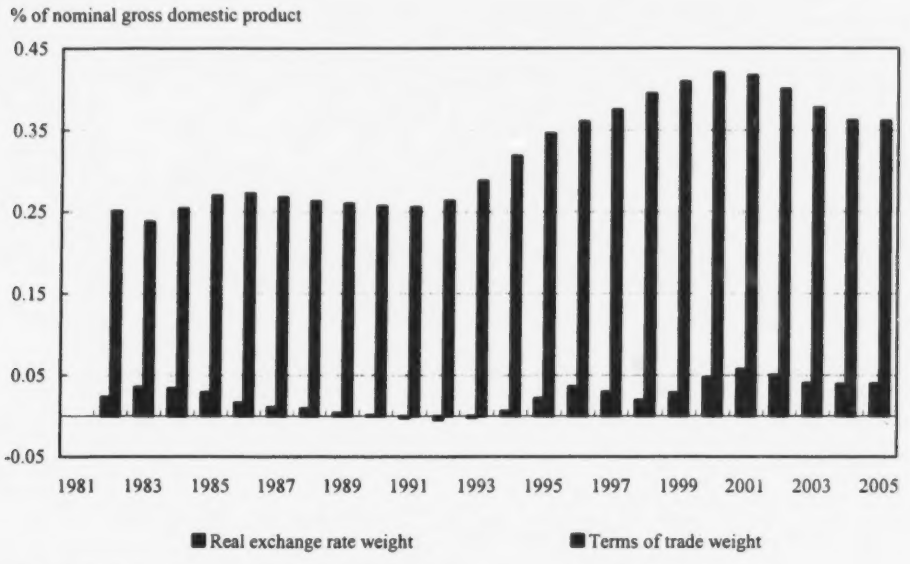
Source: Statistics Canada, author's calculations.

Figure 4
Canada



Source: Statistics Canada, author's calculations.

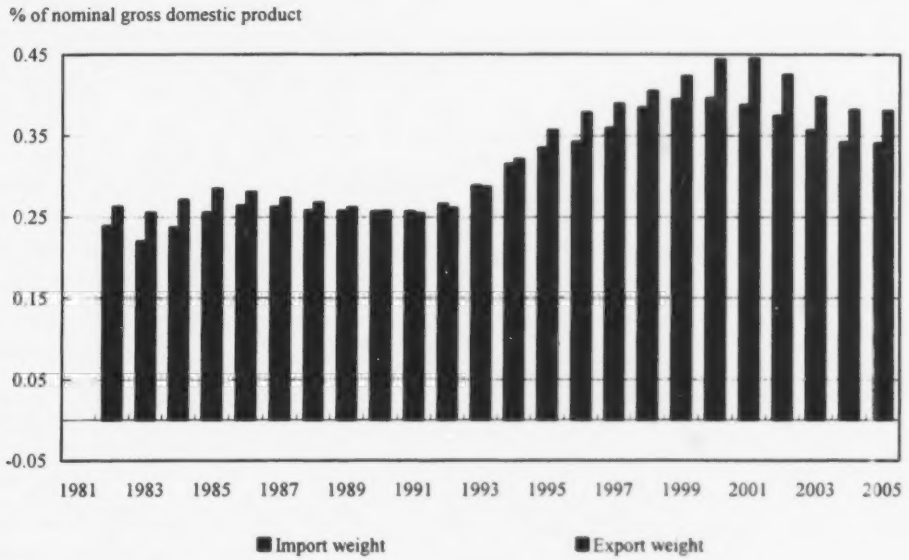
Figure 5
Canada



Source: Statistics Canada, author's calculations.

Second, the weights for the real exchange rate and terms of trade effects are not constant over time. In fact, the trade balance as a proportion of nominal GDP falls during the late 1980s and early 1990s before increasing again. The terms of trade weight declines in 1983 and in the late 1980s and early 1990s. Its decline is due to export and import shares shifting over time (Figure 6). Following the introduction of the North American Free Trade Agreement in 1993, the terms of trade weight increases until 2001 when the collapse of the technology sector and the subsequent recession in the United States lower the proportion of trade in nominal GDP.

Figure 6
Canada

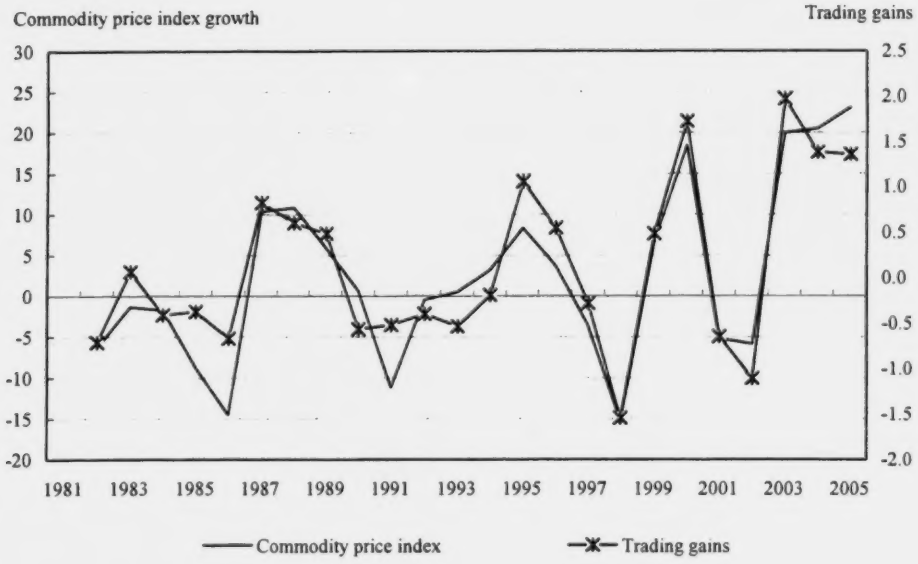


Source: Statistics Canada, author's calculations.

Third, trading gains, which are dominated by terms of trade shifts, are correlated with commodity price movements (Figure 7).[11] While the relationship is strong for the entire period, it is particularly noticeable during the latter part of the sample from 1995 to 2005.

11. Commodity prices are measured using the Bank of Canada Commodity Price Index (see CANSIM Table 176-0001).

Figure 7
Canada



Source: Statistics Canada, author's calculations.

As well, the sources of growth in the commodity price index are not constant over time. For example, there is a 14.5 % decline in the value of the index in 1986 that is driven by a 36.9 % decline in energy prices; non-energy commodity prices rise by 1.3 % in that year (Table 2). As a result, while there is an overall effect on Canada, the specific commodities driving the decline suggest that there will be differing provincial impacts in 1986. Similar differences are also present in 2000, 2003 and 2005.

Finally, although the 2003-to-2005 period is not the first time that there is a terms of trade shift, nor the first time that there is prolonged improvement (or deterioration) in the terms of trade, it is the first time that there is a prolonged period during which the terms of trade have historically large magnitude increases. It also coincides with a period during which energy and non-energy commodity prices increase in concert for an extended number of years and an appreciation of the Canadian dollar relative to the U.S. dollar. As a result, trading gains lead to noticeable increases in real GDI over real GDP. In fact, by 2005, real GDI is 3.3% higher than real GDP, which is the largest difference during the sample period.

Table 2
Commodity price indices

	Commodity price index	Non-energy commodities	Energy commodities
1982	-6.3	-8.7	-3.7
1983	-1.3	3.5	-6.7
1984	-1.7	0.6	-4.9
1985	-8.7	-7.6	-10.1
1986	-14.5	1.3	-36.9
1987	10.4	11.7	7.3
1988	10.9	20.4	-11.7
1989	5.9	3.2	15.0
1990	0.7	-5.3	17.4
1991	-11.2	-11.8	-9.6
1992	-0.4	0.6	-2.5
1993	0.5	2.9	-5.2
1994	3.3	7.5	-7.6
1995	8.4	11.1	-0.1
1996	3.8	-1.2	20.4
1997	-3.6	-4.3	-1.9
1998	-15.3	-12.5	-22.5
1999	6.7	1.5	22.1
2000	18.4	3.4	55.8
2001	-5.2	-6.9	-3.3
2002	-5.8	-6.5	-5.3
2003	20.0	8.8	36.4
2004	20.5	21.4	19.5
2005	23.1	3.9	45.4

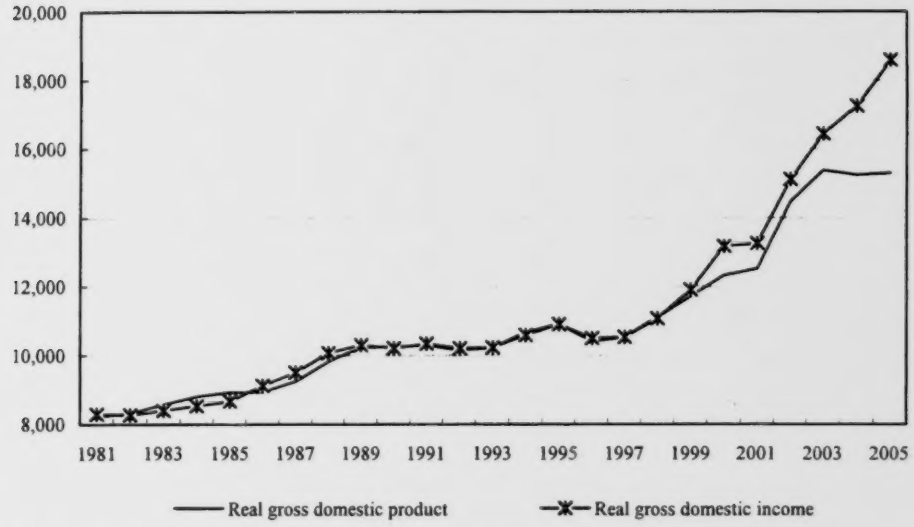
Sources: Bank of Canada Commodity Price Indices. See Statistics Canada, CANSIM Table 176-0001.

3.3 Newfoundland and Labrador

In Newfoundland and Labrador there is little deviation between real GDP and real GDI during the early part of the period (Figures 8 and 9). Beginning in 1999, however, trading gains begin to contribute importantly to real GDI growth as oil production from the Hibernia off-shore oil platform, which was launched in 1997, and rising energy prices lead to a terms of trade improvement. From 1999 to 2000 and from 2003 to 2005 trading gains add from 1.9 to 7.1 percentage points of growth to real GDI due to a series of energy price driven terms of trade improvements. The effect is so strong that from 2002 to 2005 real GDI expands by 23.2% while real GDP expands by 5.7%. As a result, real GDI is 21.3% higher than real GDP in Newfoundland and Labrador in 2005.

Figure 8
Newfoundland and Labrador

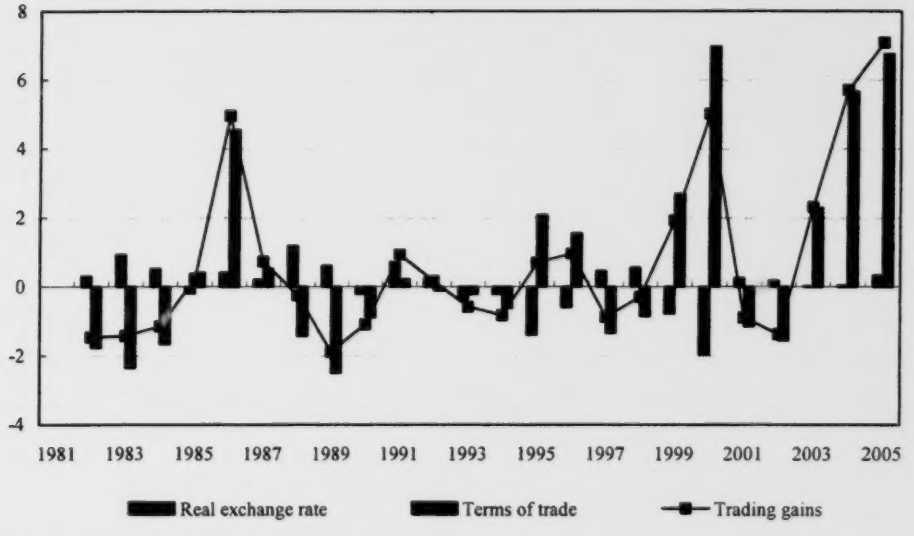
Millions of 1997 dollars



Sources: Statistics Canada, CANSIM Table 384-0002 and author's calculations.

Figure 9
Newfoundland and Labrador

Contribution to real gross domestic income growth

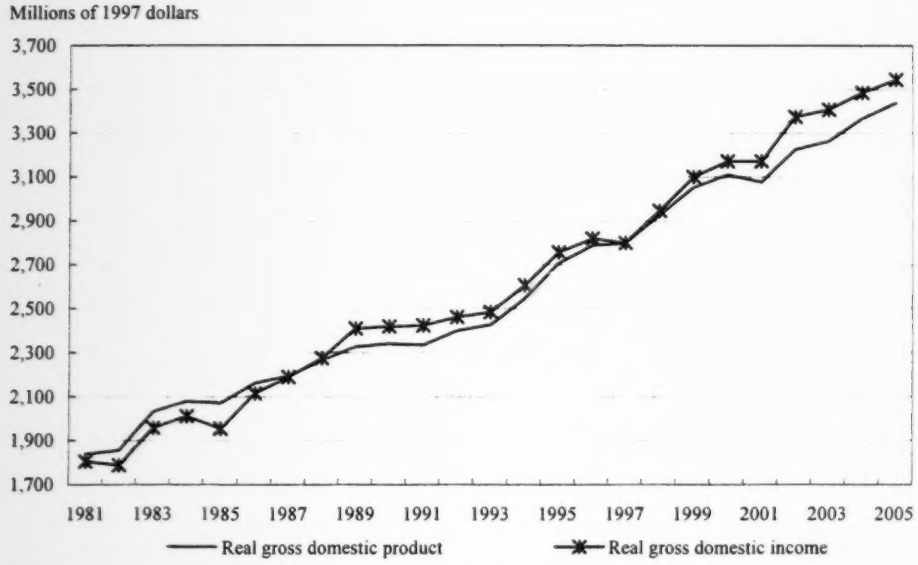


Source: Statistics Canada, author's calculations.

3.4 Prince Edward Island

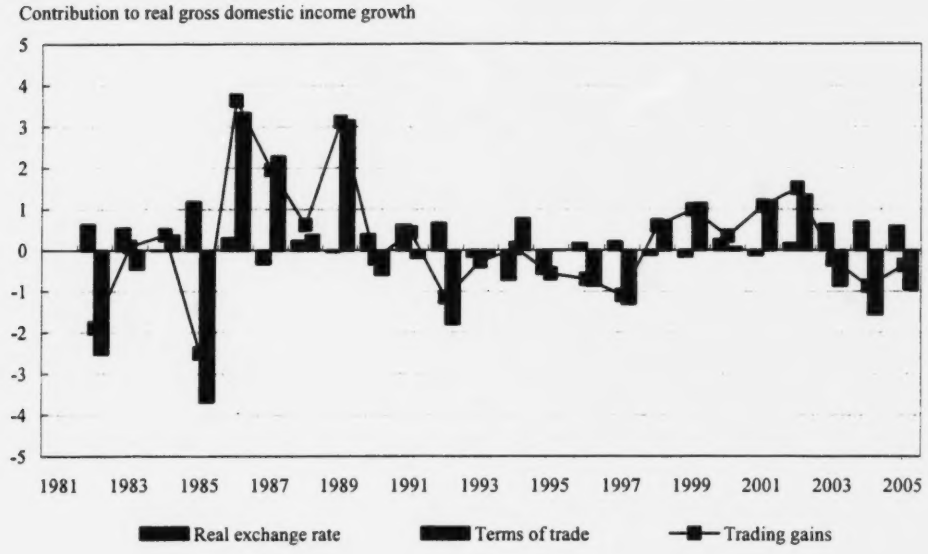
In Prince Edward Island, the largest impacts of trading gains are seen in the first half of the sample period (Figures 10 and 11). In particular, a terms of trade improvement leads to trading gains of 3.6 percentage points in 1986, when energy prices fall. With the exception of 1986, terms of trade shifts during the 1980s are dominated by changes in potato prices. Following 1989, changes in potato prices continue to contribute importantly to trading gains; however, their contribution to real GDI growth is muted. The terms of trade improvements are offset to varying degrees by real exchange rate fluctuations. Real GDI growth outpaces real GDP growth in Prince Edward Island from 1998 to 2002. From 2003 to 2005 trading gains moderately reduce real GDI growth due to terms of trade deteriorations.

Figure 10
Prince Edward Island



Sources: Statistics Canada, CANSIM Table 384-0002 and author's calculations.

Figure 11
Prince Edward Island



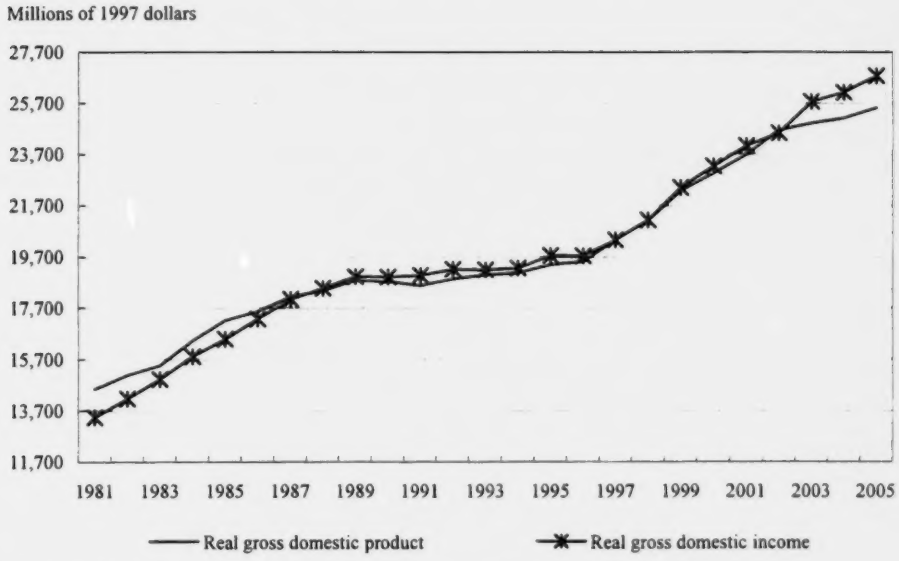
Source: Statistics Canada, author's calculations.

3.5 Nova Scotia

During the early 1980s in Nova Scotia, trading gains contribute importantly to real GDI (Figures 12 and 13). As a result, the gap between real GDP and real GDI closes rapidly. The energy price decline in 1986 contributes importantly to trading gains in that year. However, unlike most other provinces, a real exchange rate appreciation plays an important role. In Nova Scotia, the real exchange rate weight is relatively large, falling from a high of 36% in 1982 to a low of 16% in 2004 and 2005. In 1986, it is 29% of nominal GDP. When energy prices fall in 1986, there is, therefore, a large increase in nominal income in Nova Scotia due to lower imported energy costs.

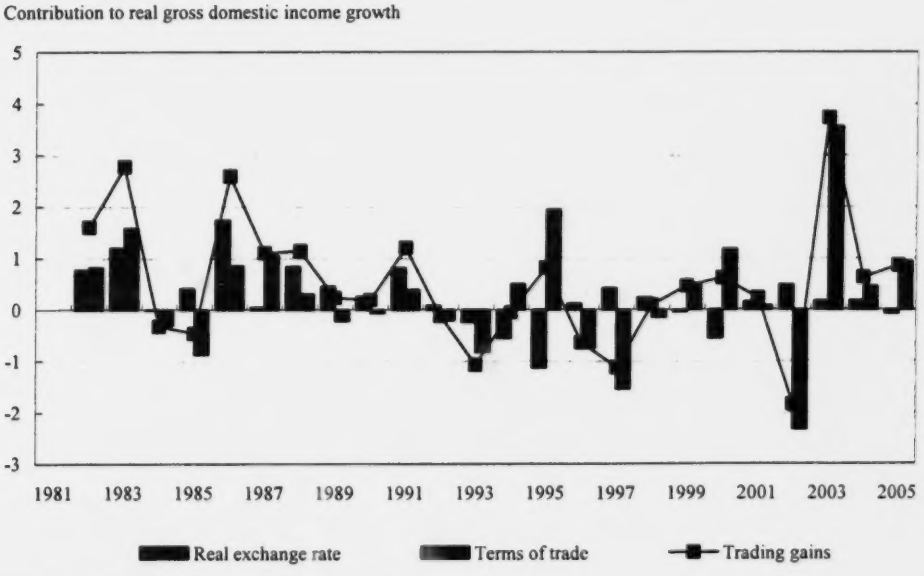
During the 1990s, trading gains in Nova Scotia do not lead to noticeable divergences between real GDP and real GDI. However, there is a terms of trade improvement in 1995 that corresponds with a 39.3% increase in pulp and paper product industry price index. In 2002, trading gains subtract 1.8 percentage points from real GDI growth. The loss is quickly reversed in 2003, when increases in commodity prices contribute to trading gains that add 3.7 percentage points to real GDI growth. In 2003 and 2004, additional commodity price increases lead to trading gains that contribute to real GDI growth. From 2002 to 2005, real GDP expands 3.6%, while real GDI increases 9.3%. As a result, real GDI is 5.0% higher than real GDP in 2005.

Figure 12
Nova Scotia



Sources: Statistics Canada, CANSIM Table 384-0002 and author's calculations.

Figure 13
Nova Scotia

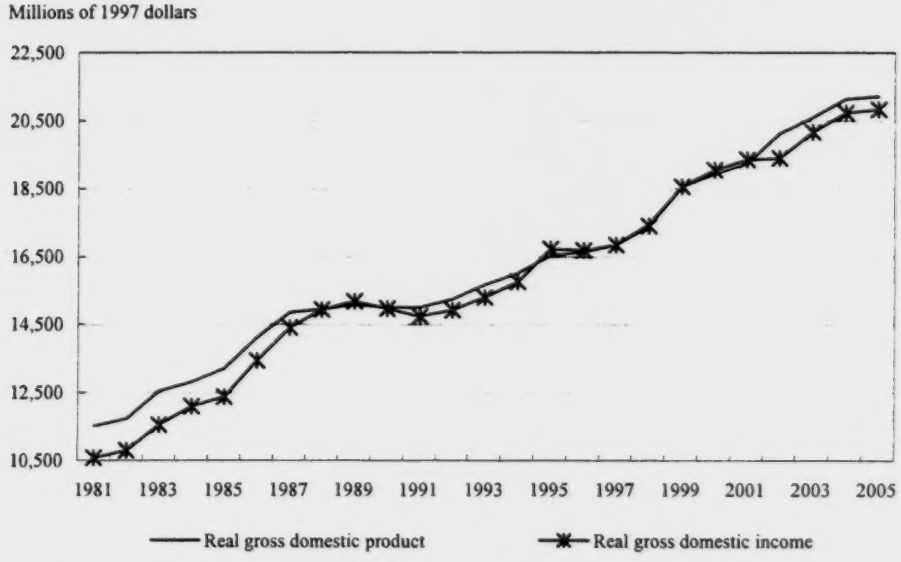


Source: Statistics Canada, author's calculations.

3.6 New Brunswick

In New Brunswick, trading gains contribute positively to real GDI growth for most of the 1982-to-1989 period (Figures 14 and 15). The energy price decline in 1986 contributes importantly to trading gains in that year. Similar to Nova Scotia, the real exchange rate effect is important. During the 1990s, growth of real GDP and real GDI are similar. In 1995, a 39.3% increase in the pulp and paper product industry price index contributes to the terms of trade improvement in that year. Despite the improvements, trading gains do not create a noticeable difference between real GDP and real GDI. In fact, the two series are similar until 2002, when a negative terms of trade deterioration leads to negative trading gains. While real GDP grows by 4.5% in that year, the negative trading gains hold real GDI growth to 0.1%. Following 2002, trading gains contribute positively to real GDI growth from 2003 to 2005. However, the gains are not large enough to offset the 2002 deterioration. As a result, the gap between real GDP and real GDI is maintained and in 2005 real GDI is 1.8% lower than real GDP.

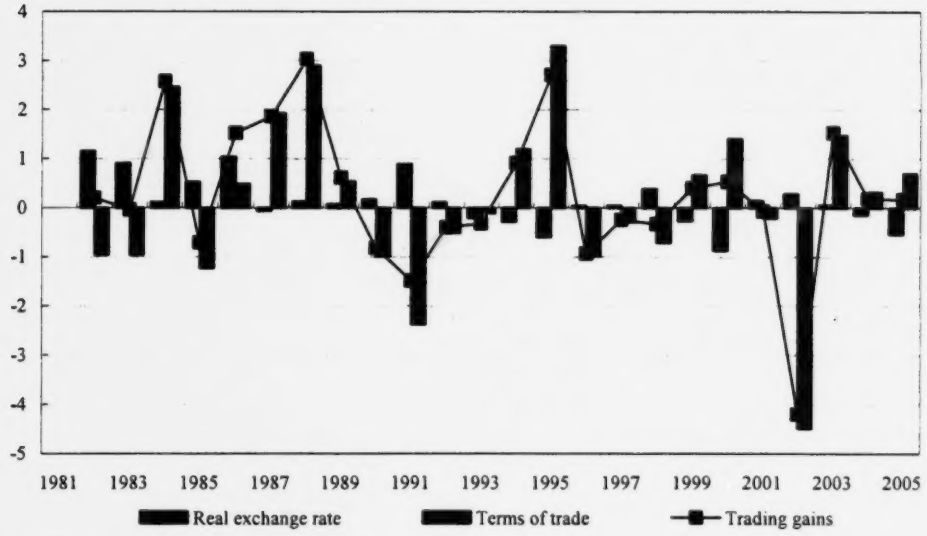
Figure 14
New Brunswick



Sources: Statistics Canada, CANSIM Table 384-0002 and author's calculations.

Figure 15
New Brunswick

Contribution to real gross domestic income growth

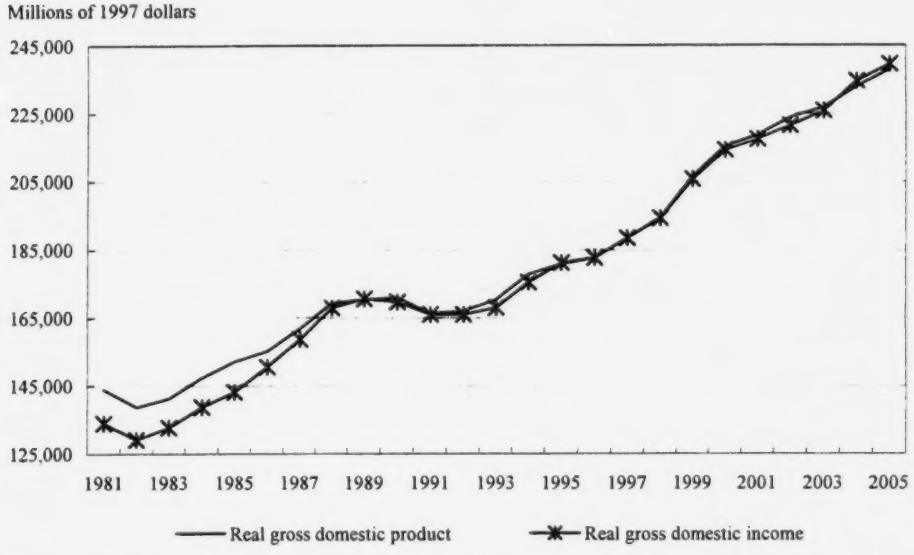


Source: Statistics Canada, author's calculations.

3.7 Quebec

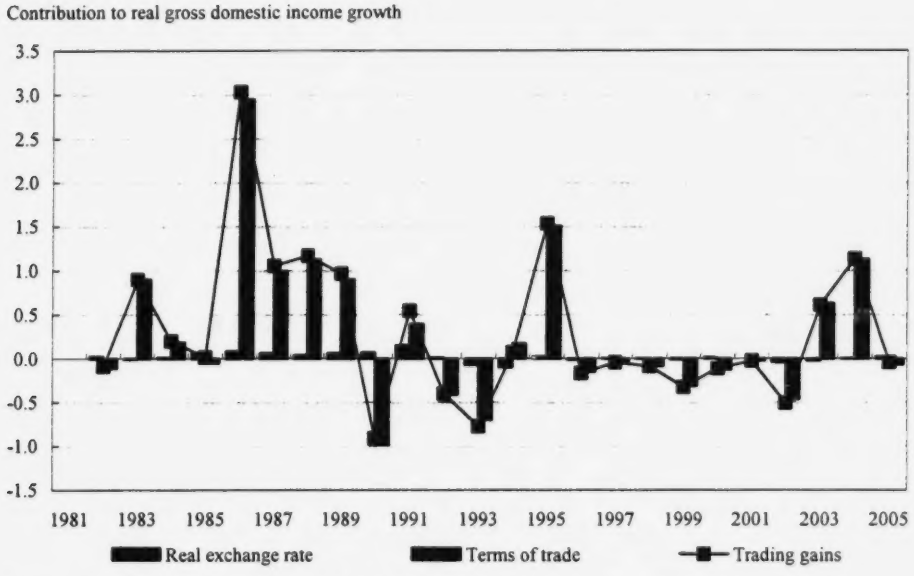
In Quebec, trading gains contribute importantly to real GDI growth in the 1980s, but have less of an effect thereafter (Figures 16 and 17). From 1983 to 1989, real GDI expands at a more rapid rate than real GDP, due primarily to increases in Quebec's terms of trade. The effect is particularly strong in 1986, when energy prices decline sharply. Real exchange rate contributions during this period are small. After 1989, real GDP and real GDI growth are similar, despite a terms of trade deterioration in 1990. This is followed by an improvement in 1995, when the pulp and paper product price index increases quickly. Quebec's trading gains are then near zero from 1996 to 2001. Commodity price increases then lead to terms of trade improvements in 2003 and 2004. As a result, from 2002 to 2005 real GDI expands 7.8% while real GDP increases 6.3%.

Figure 16
Quebec



Sources: Statistics Canada, CANSIM Table 384-0002 and author's calculations.

Figure 17
Quebec

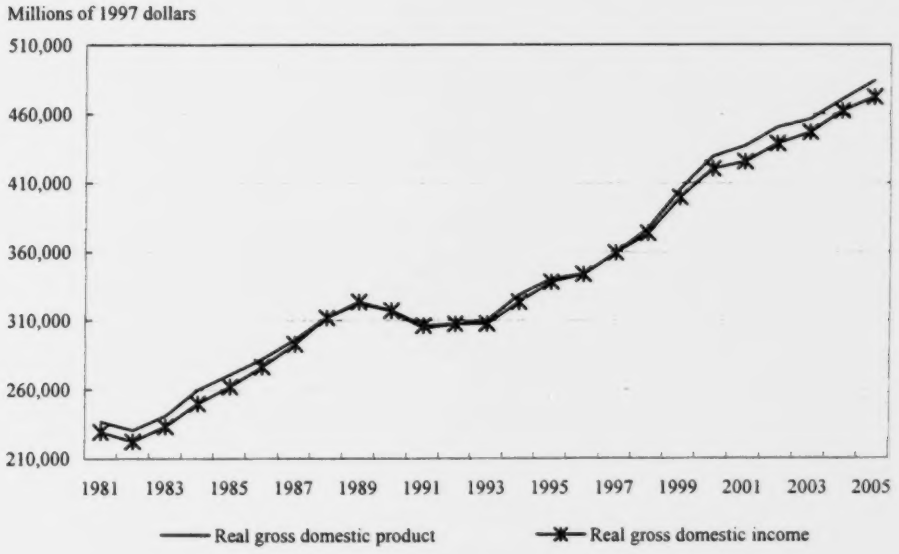


Source: Statistics Canada, author's calculations.

3.8 Ontario

In Ontario, trading gains oscillate between contributing to, and detracting from, real GDI growth over the 1981-to-2005 period (Figures 18 and 19). To a large extent the fluctuations are driven by changes in commodity prices and the nominal CDN$/US$ exchange rate. From 1982 to 1984, changes in non-energy commodity prices and the nominal exchange rate account for the bulk of the changes in trading gains. In 1986, and to a lesser extent in 1985, falling energy prices contribute importantly to a terms of trade improvement and trading gains. Following 1986, rising non-energy commodity prices continue to bolster increases in trading gains until 1990. From 1992 to 1994, trading gains detract from real GDI growth, due to an ongoing depreciation of the nominal exchange rate. Trading gains contribute positively to real GDI in 1995—coinciding with the increase in pulp and paper product industry prices—and in 1996. A series of terms of trade deteriorations from 1998 to 2002 pull back real GDI growth, creating a noticeable gap between real GDP and real GDI. The 1998 trading gain decline coincides with a 7.1% depreciation of the nominal exchange rate, while the 2000 decline coincides with a 55.8% increase in energy prices. From 2003 to 2004, increases in non-energy commodity prices help to push up trading gains, due to a terms of trade improvement. Despite the increase in 2003 and 2004, real GDI remains lower than real GDP in 2005.

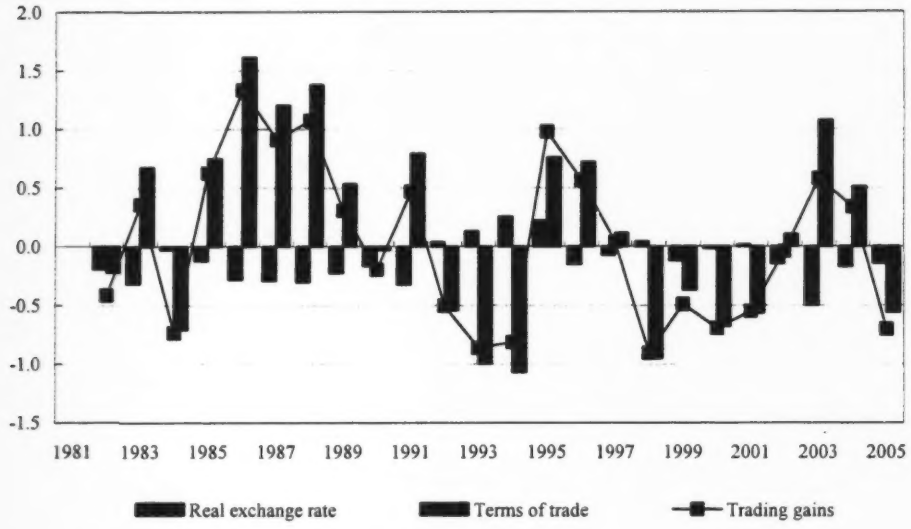
Figure 18
Ontario



Sources: Statistics Canada, CANSIM Table 384-0002 and author's calculations.

Figure 19
Ontario

Contribution to real gross domestic income growth

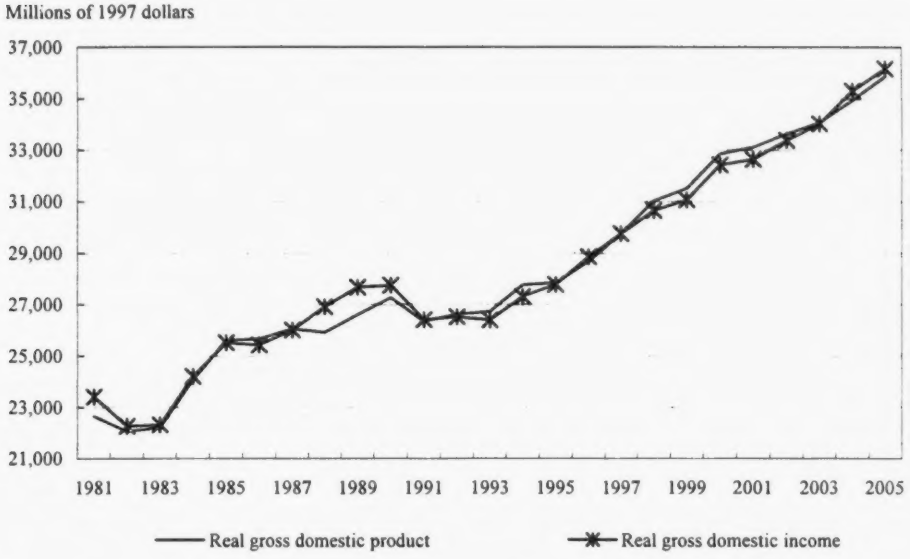


Source: Statistics Canada, author's calculations.

3.9 Manitoba

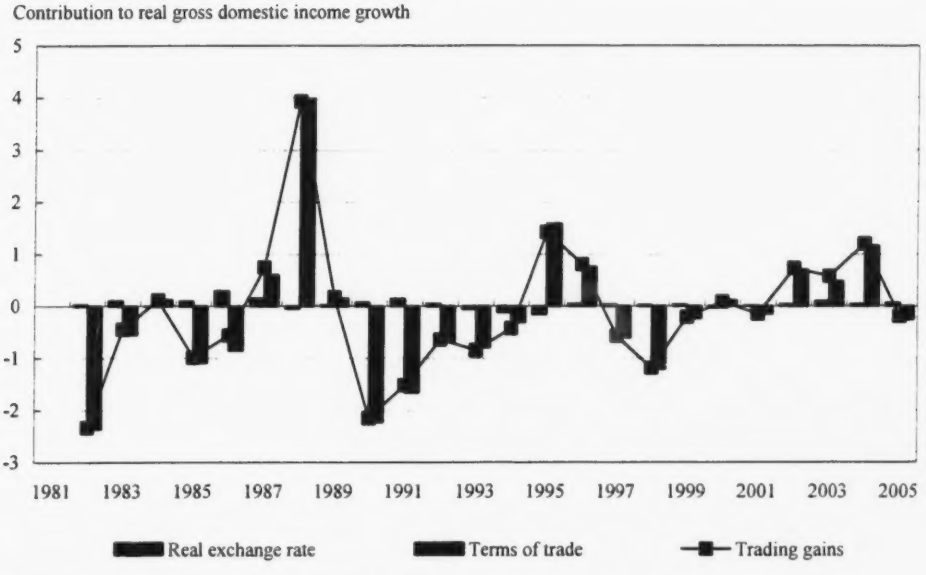
In Manitoba, trading gains tend not to be an important contributor to real GDI growth (Figures 20 and 21). Real GDP and real GDI are similar for most of the 1981-to-2005 period. Interestingly, the energy price decline in 1986 and the more recent increases in 2000, 2003 and 2005 do not appear to affect Manitoba's trading gains. The largest difference arises during the 1988 drought, when a terms of trade improvement leads to real GDI growth of 4.0% while real GDP contracts 0.5%. The improvement is not permanent, and is followed by deteriorations in the terms of trade from 1990 to 1995 and from 1997 to 1999. The cumulative effect of the deteriorations leads to real GDI being 1.3% lower than real GDP in 1999. Recently, a series of terms of trade improvements have been contributing to real GDI growth. From 2002 to 2005, real GDI expands by 8.4% while real GDP increases 6.7%. As a result, real GDI is 0.6% higher than real GDP in 2005.

Figure 20
Manitoba



Sources: Statistics Canada, CANSIM Table 384-0002 and author's calculations.

Figure 21
Manitoba

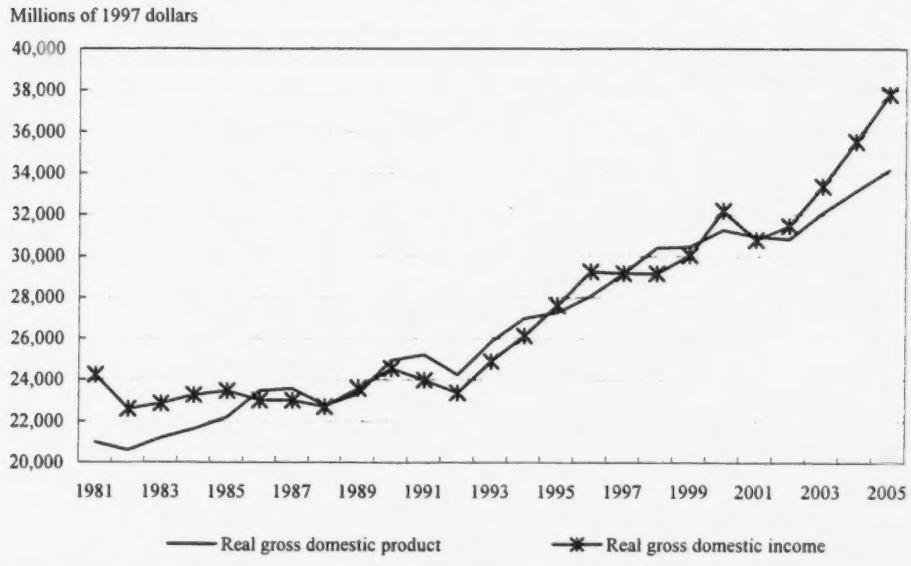


Source: Statistics Canada, author's calculations.

3.10 Saskatchewan

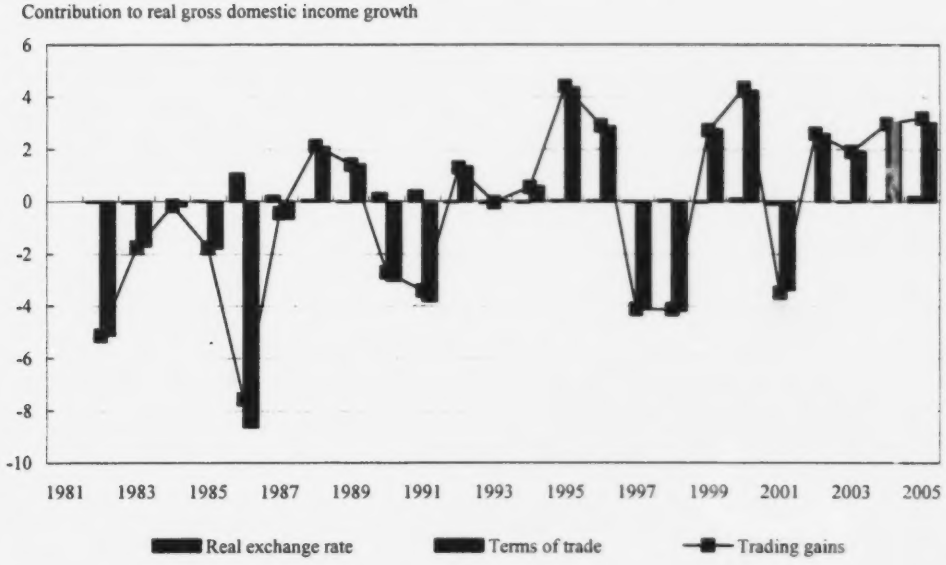
Saskatchewan's trading gains can contribute importantly to real GDI growth (Figures 22 and 23). Despite growth in real GDP during the early to mid 1980s, real GDI either decreases, or stagnates, as trading gains hold back growth, due to falling energy prices. The largest impact is in 1986, when the 36.9% decline in energy prices contributes importantly to the 15.5% terms of trade deterioration. As a result, the gap between the levels of real GDI and real GDP disappears by 1988. From 1989 to 1998, trading gains, affected by terms of trade improvements and deteriorations, oscillate between contributing to, and detracting from, real GDI growth. The level of real GDI remains similar to real GDP during this period. In 1999 and 2000, however, energy price increases lead to trading gains that raise real GDI growth. Energy price increases continue to contribute to trading gains from 2003 to 2005. In fact, from 2002 to 2005 the impact of energy prices is so strong that real GDI expands by 18.9% compared with 10.8% real GDP growth.

Figure 22
Saskatchewan



Sources: Statistics Canada, CANSIM Table 384-0002 and author's calculations.

Figure 23
Saskatchewan

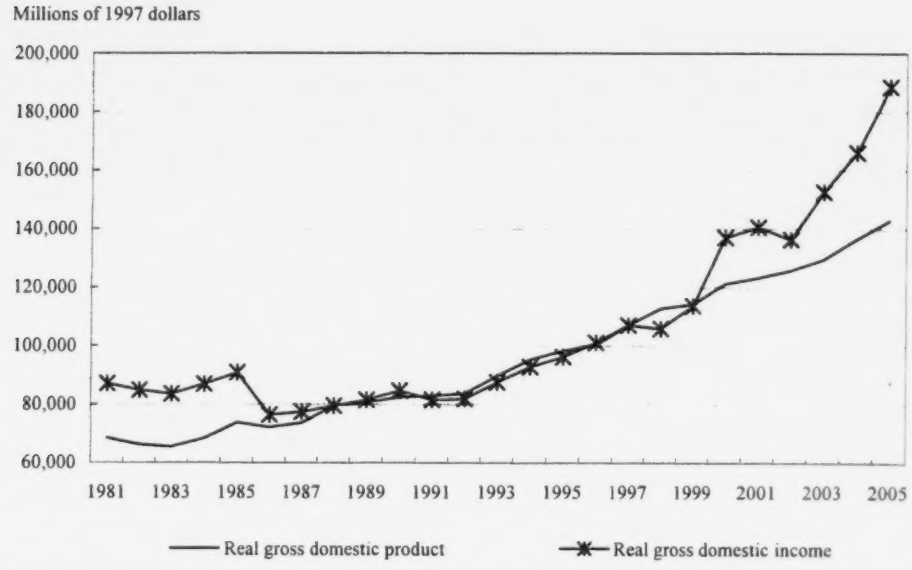


Source: Statistics Canada, author's calculations.

3.11 Alberta

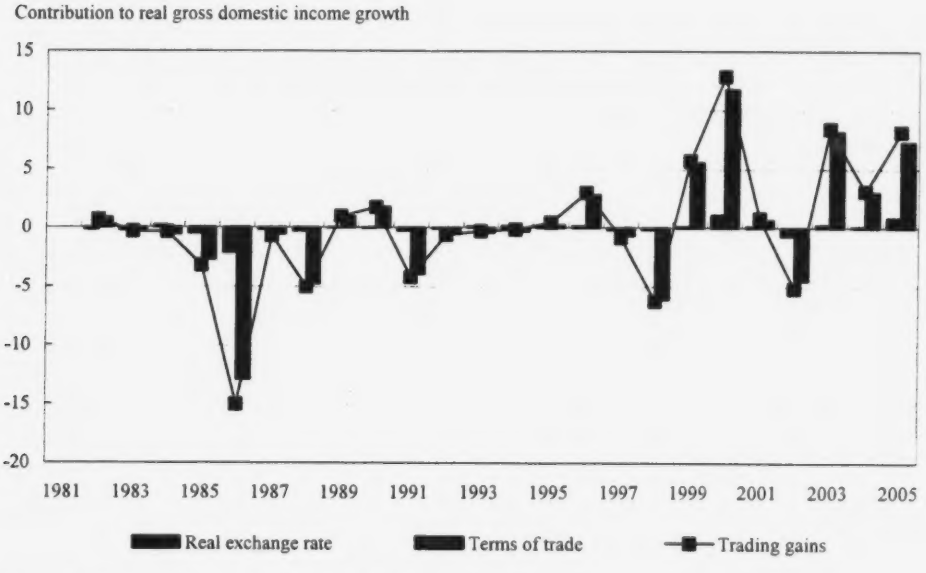
Of all provinces, Alberta is the most susceptible to changes in energy prices (Figures 24 and 25). After a series of energy induced terms of trade deteriorations in the early 1980s, the 1986 energy price decline reduces real GDI growth through trading gains. The rapid decline, combined with further reductions in real GDI growth from terms of trade deteriorations in 1987 and 1988, make the levels of real GDI and real GDP approximately equal in 1988. They remain similar until 1998, when a terms of trade deterioration again holds back real GDI growth. Following 1998, a series of terms of trade improvements, led by energy price increases, make trading gains contribute importantly to real GDI growth. From 2002 to 2005, real GDI increases by 38.0% while real GDP expands by 13.5%. As a result, real GDI in Alberta is 31.6% higher than real GDP in 2005.

Figure 24
Alberta



Sources: Statistics Canada, CANSIM Table 384-0002 and author's calculations.

Figure 25
Alberta

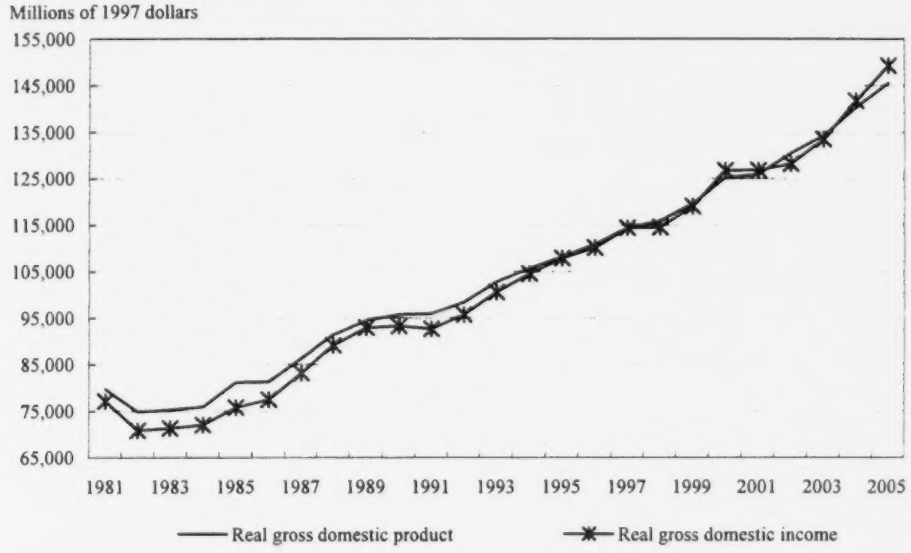


Source: Statistics Canada, author's calculations.

3.12 British Columbia

In British Columbia, trading gains oscillate over time in a manner similar to Ontario (Figures 26 and 27). However, trading gains in British Columbia are more dependent on non-energy commodities, and less dependent on exchange rate movements. In fact, with the exception of specific years, changes in non-energy commodities explain most of British Columbia's trading gains. A noteworthy exception is 1986, when the decline in energy prices contributes to trading gains. As well, an increase in pulp and paper product industry prices in 1995 appears to contribute to trading gains in that year. Overall, trading gains lead to GDI growth that tends to be stronger than real GDP growth over the entire period. The difference is not large, but over time the level of real GDI catches up to, and by 2005 surpasses, real GDP.

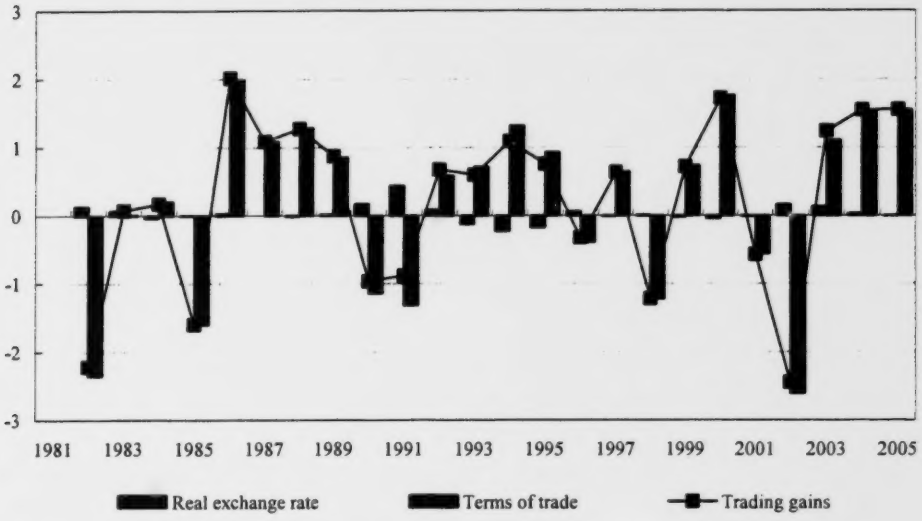
Figure 26
British Columbia



Sources: Statistics Canada, CANSIM Table 384-0002 and author's calculations.

Figure 27
British Columbia

Contribution to real gross domestic income growth



Source: Statistics Canada, author's calculations.

4. How important are trading gains?

Analysis by province shows that trading gains are important for understanding how real purchasing power evolves in the short-run. In every province during the 1980-to-2005 period trading gains affect real GDI growth. Moreover, the impact of trading gains can lead to substantial divergences between real GDP and real GDI, often for years at a time. The impact of trading gains on Canada is not as large as their impact on the individual provinces for most of the sample period. During the 1980s and 1990s, trading gains that contribute to real income growth in one province tend to be offset by losses in another. As a result, the net effect is not large.

After 2000, however, a majority of provinces begin experiencing an increase in real GDI growth from trading gains. The combined effect, by 2003, is sufficiently large that it begins to noticeably affect national real GDI growth. Trading gains continue to contribute positively to real GDI growth in 2004 and 2005, which leads to the difference between Canadian real GDI and real GDP seen in Figure 2.

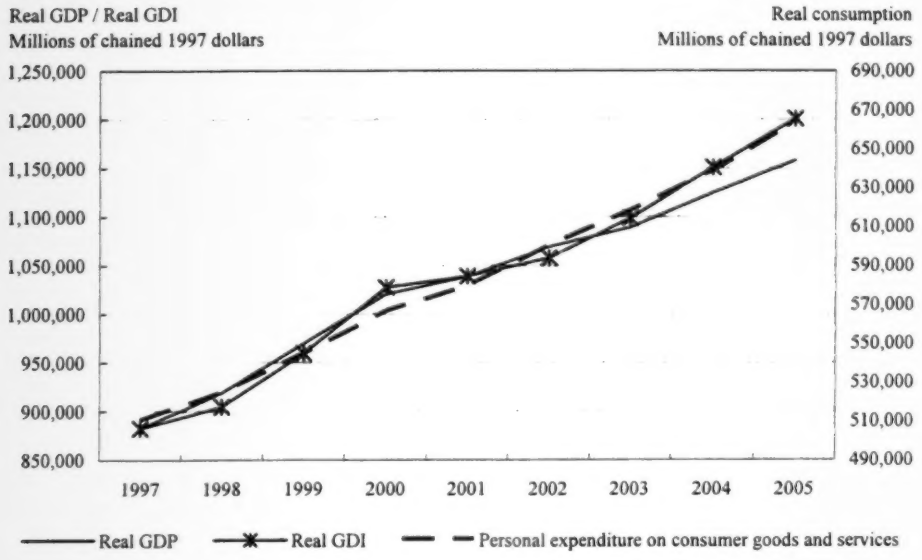
The analysis also highlights the importance of terms of trade shifts for short-run real income growth. Only in Nova Scotia and New Brunswick is the contribution to real GDI growth from real exchange rate changes comparable to the magnitude of the impact that terms of trade shifts have. In all other provinces, and for Canada as a whole, terms of trade shifts are more important for short-run real income growth than real exchange rate movements.

Finally, economic agents appear to respond quickly to trading gains. Since the data are measured at an annual frequency, it is difficult to disentangle the timing of real exchange rate and terms of trade effects. In effect, the data do not allow for analysis to distinguish between real GDI rotating through point D, before real adjustments begin, and real GDI moving toward point B, when real adjustments are underway.

However, when annual real GDI and real GDP are compared with economic aggregates, it is clear that the domestic economy has responded to changes in real GDI (Figures 28 through 31). In particular, imports and consumption closely track real GDI over the last three years, outpacing the volume of goods and services that would be consumed if real GDP was the only source of real income growth.

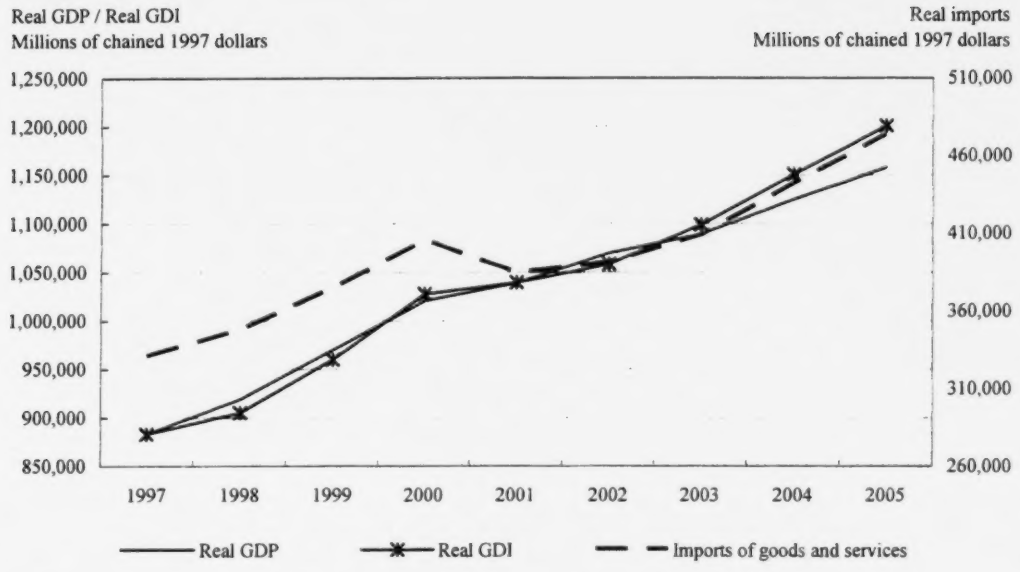
The figures show that as the terms of trade improve the economy is able, in a short period, to transform the trading gains into real consumption and real investment.

Figure 28



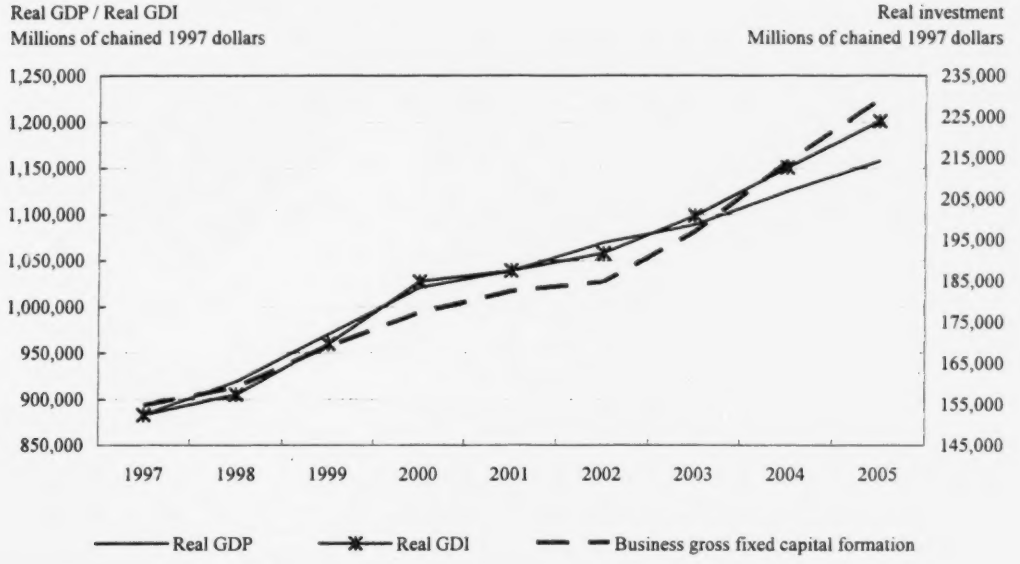
Notes: GDP=Gross domestic product; GDI=Gross domestic income.
Sources: Statistics Canada, CANSIM Tables 380-0017 and 379-0017, and author's calculations.

Figure 29



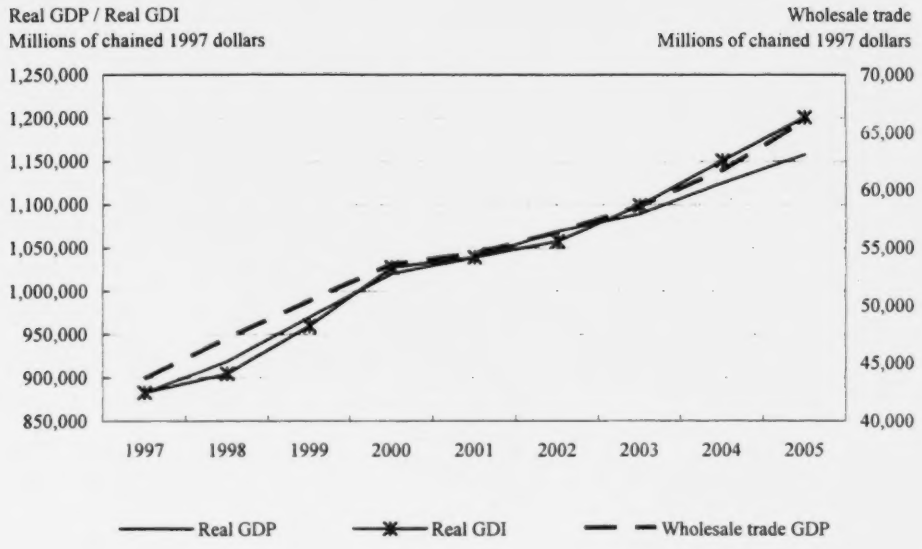
Notes: GDP=Gross domestic product; GDI=Gross domestic income.
Sources: Statistics Canada, CANSIM Tables 380-0017 and 379-0017, and author's calculations.

Figure 30



Notes: GDP=Gross domestic product; GDI=Gross domestic income.
Sources: Statistics Canada, CANSIM Tables 380-0017 and 379-0017, and author's calculations.

Figure 31



Notes: GDP=Gross domestic product; GDI=Gross domestic income.
Sources: Statistics Canada, CANSIM Tables 380-0017 and 379-0017, and author's calculations.

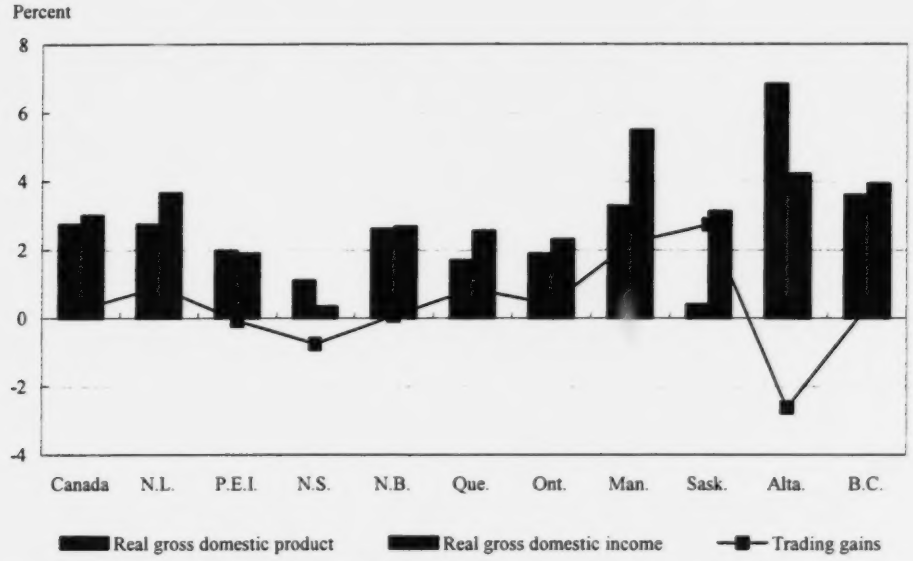
5. Conclusion

Relative price changes, whether from terms of trade or real exchange rate fluctuations, can have an impact on the purchasing power of the domestic economy. These price changes need to be accounted for when assessing the potential well-being of individuals. Simply assuming that real gross domestic product (GDP) is a measure of real income may lead to a significant misinterpretation of economic circumstances.

While it is important to take relative price shifts into account, at this point a note of caution is warranted. Real gross domestic income (GDI) and real GDP are not adjusted for international income flows. The adjustment to create gross national income (GNI) or net national income (NNI) is not possible for the provincial economies, given current data limitations. As a result, large net financial flows that can affect well-being are not captured by real GDP and real GDI measures. This point becomes important when real GDI and real GDP are compared in Newfoundland and Labrador. Real GDI makes it look like the province is doing very well, relative to real GDP. However, the commodity price driven gains in the province are likely not being wholly retained by the residents of Newfoundland and Labrador. The actual gain they are experiencing is likely somewhere in between the two measures presented in this paper. And, since there is no set of inter-provincial financial flows, it is not currently possible to deduce exactly how large the gain is.

Although real income growth derived from trading gains behaves similarly to productivity growth, its effects over the last 26 years have been temporary. While trading gains can boost real income growth, possibly for several years in a row, they are typically followed by a reversal of fortune. During the sample period, changes in relative prices that improve (lower) real income are accompanied by offsetting losses (gains) within a few years.

Figure 32



Sources: Statistics Canada, CANSIM Tables 380-0017 and 379-0017, and author's calculations.

Preliminary data for 2006 suggest that the trading gains continue to contribute importantly to provincial real GDI (Figure 32). While for Canada the effect is muted, with trading gains contributing 0.3 percentage points to real GDI growth, the Canadian average disguises inter-provincial differences. A decline in energy prices over 2006 leads to trading gains holding back real GDI growth in Alberta by -2.6 percentage points while increases in non-energy commodity prices and an appreciation of the Canada-U.S. dollar exchange rate push up trading gains in Ontario by 0.4 percentage points. Trading gains also contribute to real GDI growth in Quebec (0.8 percentage points) and in Manitoba (2.2 percentage points) and Saskatchewan (2.7 percentage points) where rising grain prices contribute to a provincial terms of trade improvement.

Finally, fluctuations in the relative price of traded to non-traded goods and services are less important for Canadian short-run real income dynamics than terms of trade shifts are. Consequently, it is important to understand what influences the terms of trade, and how the terms of trade affect the economy, when real income movements are analysed.

Appendix A Mathematical derivations for real income adjustments

By construction, Nominal GDP = Nominal GDI.

Let $\ln(P_{Y,t/t-1})$ be the Törnqvist index for the GDP deflator:

$$\ln(P_{y,t/t-1}) = \sum_i \overline{v}_{i,t/t-1} \ln(P_{i,t/t-1}) \quad i = FDD, X, M \tag{6}$$

Where $v_{i,t} = \frac{\gamma_i}{GDP} \quad \gamma_i = FDD, X, M$;

and $\overline{v}_{i,t/t-1} = \frac{(v_{i,t} + v_{i,t-1})}{2} \quad i = FDD, X, M$

Define the GDI deflator as:

$$\ln(P_{C,t/t-1}) = \ln(P_{FDD,t/t-1}) \tag{7}$$

Two estimates of real income growth can:

Real GDP growth:

$$\ln(y_{Y,t/t-1}) = \ln(GDP_{t/t-1}) - \ln(P_{Y,t/t-1}) \tag{8}$$

Real GDI growth:

$$\ln(y_{C,t/t-1}) = \ln(GDP_{t/t-1}) - \ln(P_{C,t/t-1}) \tag{9}$$

Define trading gains as:

$$\ln(T_{t/t-1}) = \ln(y_{C,t/t-1}) - \ln(y_{Y,t/t-1}) \tag{10}$$

Which reduces to:

$\ln(T_{t/t-1}) = \ln(P_{Y,t/t-1}) - \ln(P_{C,t/t-1})$

The change in real income arising from this decision is:

$\ln(T_{t/t-1}) = \overline{v}_{FDD} \ln(P_{FDD,t/t-1}) + \overline{v}_X \ln(P_{X,t/t-1}) - \overline{v}_M \Delta \ln(P_{M,t/t-1}) - \ln(P_{FDD,t/t-1})$

$$\ln(T_{t/t-1}) = (\overline{v}_{FDD} - 1) \ln(P_{FDD,t/t-1}) + \overline{v}_X \ln(P_{X,t/t-1}) - \overline{v}_M \ln(P_{M,t/t-1}) \tag{11}$$

Define changes in the terms of trade as:

$$\ln(ToT_{t/t-1}) = \ln(P_{X,t/t-1}) - \ln(P_{M,t/t-1}) \tag{12}$$

Define changes in the price of traded goods:

$$\ln(P_{T,t/t-1}) = \frac{1}{2}\left(\ln(P_{X,t/t-1}) + \ln(P_{M,t/t-1})\right) \tag{13}$$

Define real exchange rate changes as:

$$\ln(E_{t/t-1}) = \ln(P_{T,t/t-1}) - \ln(P_{FDD,t/t-1}) \tag{14}$$

The gains from trade can then be decomposed into real exchange rate and terms of trade effects as follows:

$$\ln(T_{t/t-1}) = (\bar{v}_{FDD} - 1)\ln(P_{FDD,t/t-1}) + \bar{v}_X \ln(P_{X,t/t-1}) - \bar{v}_M \ln(P_{M,t/t-1}) \tag{15}$$

Note that $(\bar{v}_{FDD} - 1) = -(\bar{v}_X - \bar{v}_M)$

$$\ln(T_{t/t-1}) = -(\bar{v}_X - \bar{v}_M)\ln(P_{FDD,t/t-1}) + \bar{v}_X \ln(P_{X,t/t-1}) - \bar{v}_M \ln(P_{M,t/t-1})$$

add/subtract $\bar{v}_X \ln(P_{M,t/t-1})$ and $\bar{v}_M \ln(P_{X,t/t-1})$

$$\begin{aligned}\ln(T_{t/t-1}) = &-(\bar{v}_X - \bar{v}_M)\ln(P_{FDD,t/t-1}) + \bar{v}_X \ln(P_{X,t/t-1}) - \bar{v}_M \ln(P_{M,t/t-1}) \\ &+\bar{v}_X \ln(P_{M,t/t-1}) - \bar{v}_X \ln(P_{M,t/t-1}) \\ &+\bar{v}_M \ln(P_{X,t/t-1}) - \bar{v}_M \ln(P_{X,t/t-1})\end{aligned}$$

Which is simplified as:

$$\begin{aligned}\ln(T_{t/t-1}) = &-(\bar{v}_X - \bar{v}_M)\ln(P_{FDD,t/t-1}) + (\bar{v}_X - \bar{v}_M)(\ln(P_{X,t/t-1}) + \ln(P_{M,t/t-1})) \\ &-\bar{v}_X \ln(P_{M,t/t-1}) + \bar{v}_M \ln(P_{X,t/t-1})\end{aligned}$$

$$\begin{aligned}\ln(T_{t/t-1}) = &-(\bar{v}_X - \bar{v}_M)\ln(P_{FDD,t/t-1}) + \frac{1}{2}(\bar{v}_X - \bar{v}_M)\left(\ln(P_{X,t/t-1}) + \ln(P_{M,t/t-1})\right) \\ &\frac{1}{2}(\bar{v}_X - \bar{v}_M)\left(\ln(P_{X,t/t-1}) + \ln(P_{M,t/t-1})\right) \\ &-\bar{v}_X \ln(P_{M,t/t-1}) + \bar{v}_M \ln(P_{X,t/t-1})\end{aligned}$$

$$\ln(T_{t/t-1}) = (\bar{v}_X - \bar{v}_M)\left\{\frac{1}{2}\left(\ln(P_{X,t/t-1}) + \ln(P_{M,t/t-1})\right) - \ln(P_{FDD,t/t-1})\right\}$$
$$+\frac{1}{2}(\bar{v}_X - \bar{v}_M)\left(\ln(P_{X,t/t-1}) + \ln(P_{M,t/t-1})\right)$$
$$-\bar{v}_X \ln(P_{M,t/t-1}) + \bar{v}_M \ln(P_{X,t/t-1})$$

Note that $\ln(E_{t/t-1}) = \frac{1}{2}\left(\ln(P_{X,t/t-1}) + \ln(P_{M,t/t-1})\right) - \ln(P_{FDD,t/t-1})$

$$\ln(T_{t/t-1}) = (\bar{v}_X - \bar{v}_M)\{\ln(E_{t/t-1})\} + \frac{1}{2}(\bar{v}_X - \bar{v}_M)\left(\ln(P_{X,t/t-1}) + \ln(P_{M,t/t-1})\right)$$
$$-\bar{v}_X \ln(P_{M,t/t-1}) + \bar{v}_M \ln(P_{X,t/t-1})$$

$$\ln(T_{t/t-1}) = (\bar{v}_X - \bar{v}_M)\{\ln(E_{t/t-1})\} + \frac{1}{2}(\bar{v}_X + \bar{v}_M)\left(\ln(P_{X,t/t-1}) - \ln(P_{M,t/t-1})\right)$$

Note that $\ln(ToT_{t/t-1}) = \ln(P_{x,t/t-1}) - \ln(P_{m,t/t-1})$

So that the gains from trade are the weighted sum of real exchange rate and terms of trade movements:

$$\ln(T_{t/t-1}) = (\bar{v}_X - \bar{v}_M)\{\ln(E_{t/t-1})\} + \frac{1}{2}(\bar{v}_X + \bar{v}_M)\{\ln(ToT_{t/t-1})\} \qquad (16)$$

References

Corden, W.M. 1960. "The geometric representation of policies to attain internal and external balance." The Review of Economic Studies. 28, 1: 1–22.

Denison, E.F. 1981. "International Transactions in Measures of the Nation's Production." *Survey of Current Business.* 61, 5: 17–28.

Diewert, E.W., and C.J. Morrison. 1985. *Adjusting Output and Productivity Indexes for Changes in the Terms of Trade*. NBER Working Paper Series. Working Paper No. 1564. Cambridge, MA: National Bureau of Economic Research.

Eurostat, International Monetary Fund, OECD, United Nations and World Bank. 1993. *System of National Accounts*. Prepared under the auspices of the Inter-Secretariat, Working Group on National Accounts. Eurostat, International Monetary Fund, OECD, United Nations and World Bank.

Kohli, U. 2006. "Real GDP, real GDI, and trading gains: Canada, 1981–2005." *International Productivity Monitor.* 13: 46–56.

Kohli, U. 2004. "Real GDP, real domestic income, and terms of trade changes." *Journal of International Economics.* 62: 83–106.

Roy, F. 2004. "Terms of trade, GDP and the exchange rate." *Canadian Economic Observer.* March 2004. Catalogue no. 11-010-XIB. Ottawa: Statistics Canada.

Salter, W.E.G. 1959. "Internal and external balance: The role of price and expenditure effects." *Economic Record.* 35: 226–238.

Statistics Canada. 1977. National Income and Expenditure Accounts, Quarterly Estimates. Second quarter 1977. Catalogue no. 13-0001-XIB. Ottawa: Statistics Canada.

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